TECHNICAL MANUAL

OVERHAUL INSTRUCTIONS

STORAGE TANK, LIQUID OXYGEN TYPE TMU-20/E, 5000 GALLON CAPACITY

PART NO. 112220

NSN 3655-01-252-1257

CRYENCO, INC.

(F41608-86-D-0279)

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FOREWORD/PREFACE

Purpose. This technical manual will provide the using activity with repair and overhaul instructions for the 5000 gallon Liquid Oxygen Storage and Transfer Tank, Type TMU-20/E.

Scope. This manual will provide the using activity with applicable information required on the disassembly, cleaning, inspection, repair, replacement, assembly, and testing associated with the use of cryogenic equipment and products. Any corrections regarding this technical manual should be submitted in accordance with T.O. 00-5-1.

Throughout this manual the unit will primarily be called the Tank. It may also be called the Storage Tank. Tanks referenced but not covered by this manual will contain additional descriptions. Example: supply tank and receiving tank. Liquid oxygen may be referred to as the product, or abbreviated LOX in parts of this manual.

SAFETY SUMMARY

The following are general safety precautions and instructions that people must understand and apply during many phases of operation and maintenance to ensure personal safety and health and the protection of Air Force property. Portions of this may be repeated elsewhere in this publication for emphasis.

WARNING AND CAUTION STATEMENTS

WARNING and **CAUTION** statements have been strategically placed throughout this text prior to operation or maintenance procedures, practices or conditions considered essential to the protection of personnel (**WARNING**) or equipment and property (**CAUTION**). a **WARNING** and **CAUTION** will apply each time the related step is repeated. Prior to starting any task, the **WARNINGS** or **CAUTIONS** included in the text for the task will be reviewed and understood.

QUALIFIED PERSONNEL

Only qualified personnel shall be authorized to operate and perform maintenance on this equipment.

PERSONAL PROTECTIVE EQUIPMENT (PPE)

If unique local conditions make compliance with the protective clothing or other occupational health requirements specified in this manual unnecessary or impractical, obtain an evaluation of the operation from the Bioenvironmental Engineer. The Bioenvironmental Engineer and Base Safety Office will determine the required precautions.

KEEP AWAY FROM ABSORBENT MATERIALS

Liquid oxygen must be kept away from absorbent materials such as rags, wood, paper, and clothing. These materials may trap the oxygen gas and later be ignited by any source of spark or flame.

KEEP AWAY FROM HYDROCARBONS

Liquid oxygen is not compatible with hydrocarbons. Forms of hydrocarbons are oils, greases, gasoline, tar, and asphalt. Liquid oxygen in contact with hydrocarbons presents a severe explosive hazard. The equipment, its components, and tools used in maintenance must be kept free of hydrocarbons.

SMOKING

Do not smoke or permit smoking within fifty (50) feet of Tanks in liquid oxygen service. Do not carry sources of flame in the vicinity of Tanks in liquid oxygen service. Use caution in smoking immediately after being exposed to liquid oxygen vapors as these vapors may be still trapped in clothing.

BODILY CONTACT

Never allow liquid oxygen or the cold piping on the equipment to contact the skin. The extremely low temperatures created by liquid oxygen will immediately freeze the body area and result in severe frostbite.

SAFETY SUMMARY--CONT.

EMERGENCY TREATMENT OF BODILY CONTACT

In the event of bodily contact with liquid oxygen or the tank piping, remove the victim from the exposure immediately. Do not attempt to rewarm any body part as this should be accomplished by proper medical personnel. Transport the patient to an emergency room of a hospital or clinic as soon as possible. Keep the patient dry and warm enroute to the emergency room. Upon arrival, identify the injury as exposure to liquid oxygen.

UNAUTHORIZED CONTAINERS

Never put liquid oxygen in any container without proper safety devices (e.g. thermos bottle). When heated, liquid oxygen will expand rapidly and build pressures to extremely high levels. The results of pressure buildup without safety devices may result in an explosion.

VENTILATION

Adequate ventilation must be provided for personnel for tank functions such as transfer operations, filling, draining, purging, painting, welding, brazing, and cleaning.

LIFTING

Equipment used in lifting and moving the tank must be of sufficient rating to handle the weights involved.

PART CLEANLINESS

All parts used in liquid oxygen service must be kept clean and free of hydrocarbons. Never use shop air to dry cleaned parts. Ultraviolet lights are used to check parts that have been cleaned. Overexposure to ultraviolet light can result in conjunctivitis (inflammation of the inner eyelid and eyeball) and possible skin burns which could result in skin cancer. Common hardware components not properly packaged that come in contact with liquid or gaseous product, shall be properly cleaned prior to use.

PURGING

When purging a tank, all piping and valves become hot enough to burn. Ensure tank components are at ambient temperatures before attempting handling or removal after purging operations.

PURGE AND SPLASH HAZARDS

When discharging cryogenic liquids from service hoses, blow down lines or drain valves, open the valves slowly to avoid being splashed by the cryogenic product.

WELDING AND BRAZING

Welding or brazing operations produce heat, metal fumes, injurious radiation, metal slag, and airborne particles. Proper protective equipment must be worn before welding or brazing. Never look directly at the arc when welding or the flame during brazing. Never attempt welding or brazing operations near Teflon components (e.g. anti-seize tape). Teflon components deteriorate at high temperatures and emit poisonous gases. Proper ventilation is a must when welding or brazing.

SAFETY SUMMARY--CONT.

TANK VACUUM

Never break the vacuum to air in the annular space, with or without liquid in the tank. The liquid must be drained and the tank warmed to ambient temperature. Break the vacuum to dry nitrogen gas.

CLEANERS/CHEMICALS/PAINTS/PRIMERS

Some cleaners, chemicals, paints, and primers have adverse effects on skin, eyes, and the respiratory tract. Observe manufacturer's Warning labels; Material Safety Data Sheet (MSDS) instructions for proper handling, storage, and disposal; and current safety directives. Use only in authorized areas. Unless otherwise indicated in the text, use as described in this TO should not result in any immediate health concerns. Consult the local Bioenvironmental Engineer and Base Safety Office for specific protection equipment and ventilation requirements.

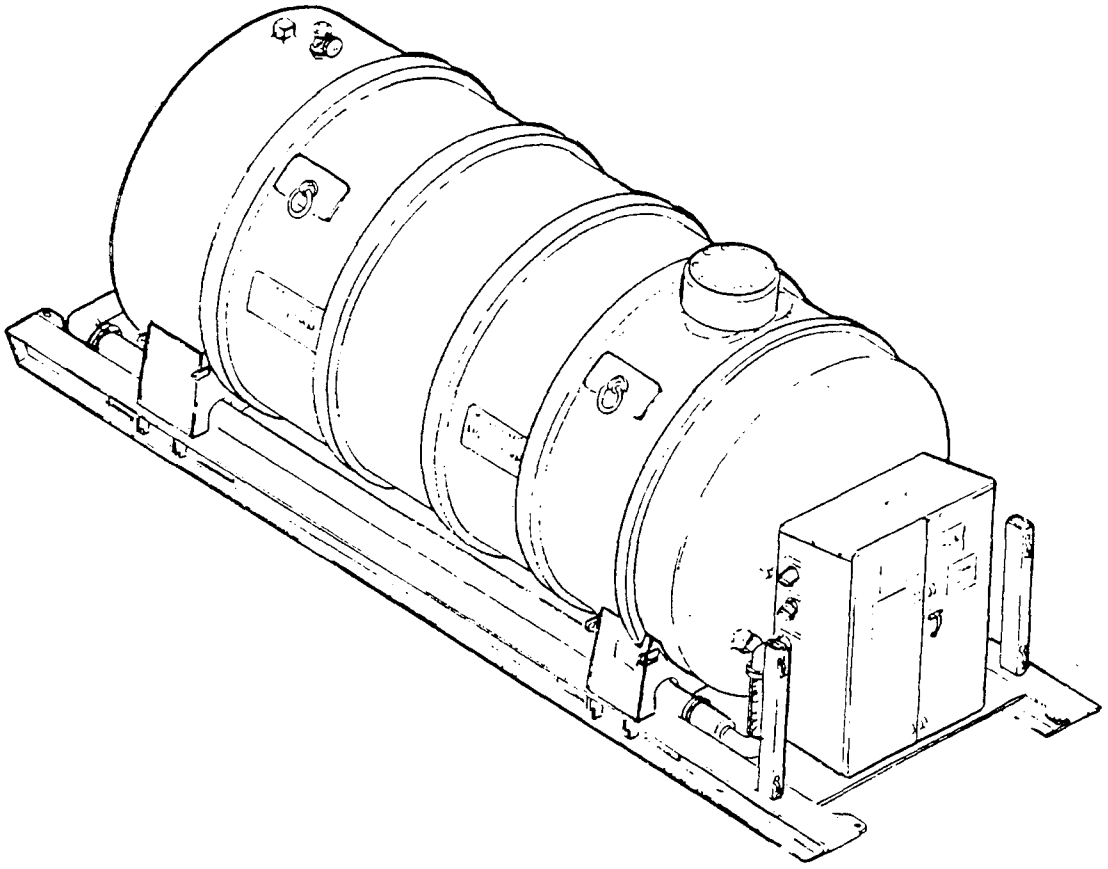


Figure 1-1. Tank, Storage, Liquid Oxygen, Type TMU-20/E.

SECTION I
GENERAL INFORMATION

1-1. INTRODUCTION.

This manual contains repair and overhaul instructions for the 5000 Gallon Liquid Oxygen Storage and Transfer Tank, Type TMU-20/E, Part No. 112220, manufactured by Cryenco Inc., Denver, Colorado. Throughout this manual, the 5000 Gallon Liquid Oxygen Storage and Transfer Tank (Figure 1-1) will be referred to as the storage tank. These instructions enable the user to disassemble the equipment, repair and replace defective parts, perform cleaning and inspection procedures, then, reassemble and test the equipment to ensure that it is in serviceable condition. All repairs must be conducted in a well-ventilated area to prevent a concentration of vapors from venting and spills. All safety precautions must be followed.

1-2. PURPOSE OF EQUIPMENT.

The storage tank is intended for use in storing liquid oxygen and transferring it to the aircraft servicing system. It will store up to 5000 gallons of product at its atmospheric boiling temperature (-297°F). The storage tank must be empty when transported.

1-3. EQUIPMENT DESCRIPTION.

The storage tank is a complete, air transportable, self-contained unit, consisting of a 5000-gallon cryogenic storage tank, controls, indicators and appropriate piping for the receiving and transfer of liquid oxygen. Table 1-1 presents the leading particulars for this assembly.

1-3.1. Tank Assembly. The tank assembly consists of an inner vessel for the containment of liquid oxygen, suspended inside an outer vessel or jacket. The inner vessel is wrapped with layers of aluminum foil and glass paper, and isolated from the outer jacket by an annular vacuum space. In essence, the tank portion of the storage tank is a large Dewar, flask or thermos bottle.

1-3.2. Vacuum Seal-Off Valve (See Figure 3-11). The vacuum seal-off valve (V-1), or evacuation valve, is at the top rear surface of the tank assembly. It is a standard diaphragm valve assembly, designed for the withdrawal of air from the annular space.

1-3.3. Control Housing (See Figure 3-9). The control housing is mounted at the front of the storage tank and provides protection for the major controls, piping and instrument panel assembly. A hinged door provides access to controls and instrument panel. The liquid level gage and pressure gage are mounted on the instrument panel.

1-3.4. Fill/Drain Line Assembly (See Figure 3-8). The fill/drain line assembly is located in the middle of the control housing and extends to the front of the control housing. It consists of fill/drain line shutoff valve (V-6), pressure buildup coil control valve (V-7) and associated piping. The right side of the fill/drain assembly connects to the PBU assembly and the left side connects to the tank fill/drain outlet.

1-3.5. Service Line Assembly (See Figure 3-7). The service piping line is located on the lower center of the control housing. The right side terminates with the service hose assembly and the left side connects to the tank service line outlet.

1-3.6. Pressure Buildup Unit (PBU) or Coil (See Figure 3-4). The pressure buildup coil is a tube type heat-exchanger. It is routed around both sides and rear end of the tank. Liquid product is admitted to the coil, where it expands as it assumes a gaseous form and provides transfer pressure to the tank. The right side is connected to the fill/drain line piping assembly and the left side is connected to the vent line piping assembly.

1-3.7. Vent Line Assembly (See Figure 3-6). The vent line assembly is located in the upper part of the control housing and extends through the left and right side of the control housing. It consists of relief valve (RV-3), rupture disc (SD-1), vapor vent line shutoff valve (V-8) and associated piping. The upper left end connects to the tank, the lower left end connects to the PBU assembly, and the right side vents to atmosphere.

1-4. LEADING PARTICULARS.

A summary of leading particulars for the storage tank is listed in Table 1-1.

1-5. RELATED PUBLICATIONS.

This manual is designed to be used with the Operation and Maintenance Manual, T.O. 37C2-8-36-1 and the Illustrated Parts Breakdown Manual, T.O. 37C2-8-36-4.

Table 1-1. Leading Particulars

General Information	
Identification	Liquid Oxygen Storage Tank, Type TMU-20/E
Manufacturer	Cryenco, Inc., Denver, Colorado
Part Number	112220
National Stock Number	NSN 3655-01-252-1257
Capacity:	
Gross Volume	5100 gallons
Net Volume	5000 gallons
Weight:	
Empty	25,000 Pounds
Full	68,750 Pounds
Evaporation Rate	Less than 120 lbs. of liquid oxygen per 24 hours.
Over-All Dimensions	
Length	300 inches
Width	96 inches
Height	120 inches
Inner Vessel	
Design and Fabrication Criteria	Section VIII of ASME Code
Type	Cylindrical Vessel, 304 Stainless steel welded construction with torispherical heads.
Operating Pressure (Max.)	50 psig
Outer Vessel	
Type	Cylindrical Vessel, carbon steel welded construction, and torispherical heads
Insulation	
Type	Multi-layer (incorporating aluminum/reflective radiation barriers, glass paper) and vacuum.
Manual Control Valves	
Type	Bronze-body, globe valve with replaceable body seat, Teflon packing and KEL-F disc. Extended stainless steel stem.
Leakage	Not to exceed 2 cubic inches of free air, or oxygen gas per hr. per inch of valve nominal size.

Table 1-1. Leading Particulars--Cont.

Filters	
Type	In-line stainless steel wire mesh element fused to filter housing.
Rating	10-micron nominal, 25-micron absolute.
Tank Relief Valve	
Type	Bronze-body cryogenic safety relief valve. Stainless steel spring, special Teflon seat. Meets ASME Boiler & Pressure Vessel Code, Section VIII requirements. 2-inch IPS inlet and 2½-inch IPS outlet. Set at 60 ±5 psig.
Rupture Disc Assembly	
Type	Union, with 2-inch inlet and outlet. Rated at 91 $^{+9}_{-5}$ psig.
Pressurization (Pressure Buildup) Coil	
Type	Exposed tube heat-exchanger coil
Line Relief Valves	
Type	Inlet pop-type, 75 ±5 psig.
Liquid Level Indicator	
Type	0-5500 gallon, differential pressure (single bellows), dual scale (oxygen and nitrogen)
Tank Pressure Indicator	
Type	0-100 psig. Bourdon tube type.
Vacuum Indicator	
Type	Thermocouple (FSN 6685-00-877-9593)
Connections	
Fill/drain Couplings	3½-inch male LOX (per USAF Dwg. 8991187).
Service Hose Couplings	1-inch female LOX (per USAF Dwg. 8991174).
Vacuum Seal-Off	1¼-inch, 150 lb. stainless steel flange.
Vapor Vent Discharge	3-inch female pipe thread (NPT)
Service Hose	
Type and Dimensions	1-inch ID x 10 Feet. Liquid oxygen transfer (per USAF Dwg. 59C6671-2)

SECTION II
SPECIAL TOOLS AND TEST EQUIPMENT

2-1. **GENERAL.**

Special tools and test equipment required for repair, overhaul, and testing the storage tank are listed in Table 2-1 and shown in Figures 2-1 and 2-2.

Consumable materials are listed in Table 2-2. Approved equivalent tools and materials can be substituted where appropriate. Related Publications are listed in Table 2-3.

Table 2-1. Special Tools and Test Equipment

Tool/Equipment No.	Fig. No.	Nomenclature	Use and Application
Consolidated Electrodynamics Corporation 24-120A	---	Helium Mass Spectrometer	Leak Checking.
Type KTC-2 (NSN 4310-00-323-8866, P/N 806889	---	Vacuum Pump, electrically driven 220/440 VAC	Evacuation (Pumpdown) operations.
6695-01-101-5691YD	---	Liquid Oxygen Sampler	Contaminant Testing.
Type GSU-62M	---	Air Purging Unit, 220/440 VAC	Purging Operations.
3655-00-106-6647YD	---	Seal-Off Valve Operator	Evacuation (Pumpdown) operations, vacuum testing.
Part No. 15840 (NSN 6685-00-827-1706)	2-1	Vacuum Gage	Check Annular Space vacuum.
Millipore Cat. No. XX4504700	---	High Pressure Filter Holder	Cleanliness Testing.
Millipore Cat. No. SMWP 04700 04700	---	Filter, Type SM, 5.0	Cleanliness Testing.
NSN 6685-01-117-9913YD P/N 50C-0016-2	2-2	Dual Efficiency Meter	Evaporation Loss Testing.
4-4-1217-21-T,-22-T	---	Globe Valve Seat Wrench	Globe Valve Disassembly.

Table 2-2. Consumable Materials

Material	Specification	National Stock No.
Solvent, Trichlorotrifluoroethane (Freon)	MIL-C-81302	6850-00-681-5688
Leak Detection Compound, Oxygen Systems, Type 1	MIL-C-25567	6850-00-621-1820
Grease, Stopcock (liquid oxygen compatible)	KEL-F-90	9150-00-745-2760
Grease, Vacuum	MIL-G-27617	
Primer, Organic Zinc	AF 7545352 (MIL-P-85582)	
Paint, Polyurethane	MIL-C-85285	
Tape, Antiseize, Tetrafluoroethane, 1/2 inch	MIL-T-27730	8030-00-889-3535
Nitrogen	BB-N-411, Type 1, Grade A	6830-00-285-4769
Kit, Compound, Sealing	953-0001 (Varian Assoc.)	8030-00-998-3321

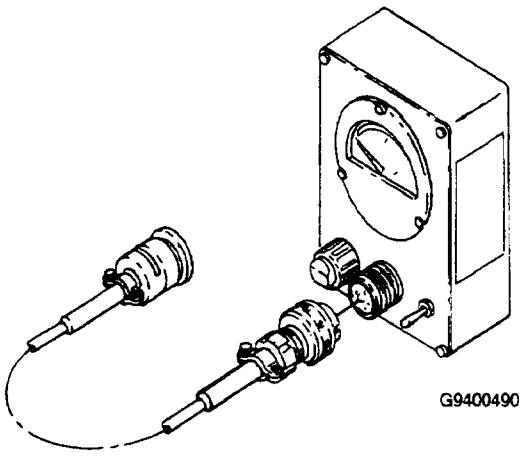


Figure 1-1. Vacuum Gage

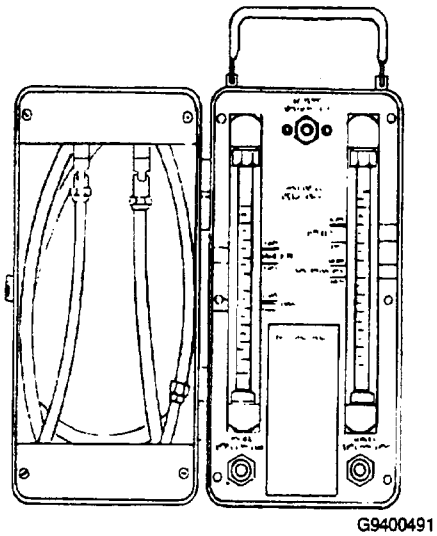


Figure 2-2. Dual Efficiency Meter

Table 2-3. Related Publications

Publication No.	Title
T.O. 00-5-1	AF Technical Order System
T.O. 00-25-107	AFLC Area Support
T.O. 00-25-172	Ground Servicing of Aircraft and Static Grounding/Bonding
T.O. 00-25-223	Integrated Pressure Systems and Components
T.O. 00-25-252	Certification of USAF Aircraft and Missile Welders
T.O. 00-25-229	Valves and Regulators
T.O. 33D2-10-60-1	Cryogenic Sampler
T.O. 34Y5-3-37-1	Operation and Maintenance Instructions Power Driven Rotary Vacuum Pump
T.O. 00-35D-54	USAF Material Deficiency Reporting and Investigating System
T.O. 35-1-3	Painting and Marking of USAF Aerospace Ground Equipment
T.O. 37C2-8-36-1	Liquid Oxygen Storage Tank, Operation and Maintenance Instructions
T.O. 37C2-8-36-4	Liquid Oxygen Storage Tank, Illustrated Parts Breakdown
T.O. 37C2-8-1-116WC-1	Inspection Work Cards
T.O. 37C2-8-27-11	Operation, Maintenance and Overhaul Instructions with Illustrated Parts Breakdown for Meter, Dual Efficiency
T.O. 37C11-3-1	Vacuum Gage (Portable), Part No. 15840
T.O. 36G2-3-1	Air Purging Unit, Type GSU-62/M
T.O. 37C11-1-1	Cleaning of Pressure Gages Used
AFOSH-STD-127-66	Occupational Safety General Industrial Operations
AFR-144-1	Fuels Management
MIL-STD-808(USAF)	Finishes, Protective, and Codes for Finishing Schemes for Ground Support Equipment
T.O. 35-1-3	Corrosion Prevention, Painting and Marking of USAF Support Equipment (SE)

SECTION III
DISASSEMBLY

3-1. SCOPE.

This section contains instructions for disassembling the storage tank. These instructions provide for the removal of all components down to the authorized level of repair, and, for the further dismantling of components where parts may be replaced, repaired, cleaned, tested, or inspected.

3-2. PREPARATIONS AND PRECAUTIONS.

Certain general precautions and preparations must be considered prior to disassembly of any assembly, subassembly or component of the storage tank. A review of the following paragraphs is suggested before disassembly is attempted:

a. Only qualified personnel will be authorized to disassemble or repair the storage tank. Safety precautions must be followed. If unsure of safety requirements, consult your Safety Officer.

b. All procedures must be accomplished in a clean, well-ventilated area of sufficient size to facilitate handling operations. An environmentally controlled area is ideal, but may be impractical. Maintenance and repair personnel must take every precaution to assure the maximum cleanliness of all parts.

c. Wear clean, white, lint-free gloves while performing the tasks outlined in this section. Use polyethylene bags to protect all clean parts and to seal all piping outlets until ready for assembly.

d. Disassembly of the storage tank and its components should be limited to that necessary for repair or replacement, or for required cleaning and inspection. Components of the storage tank that are removed solely for access to other components should be tagged and laid aside for subsequent reassembly. If removed parts are in contact with either the product or the vacuum, they must be protected against contamination by polyethylene bags, and stored in a suitable place for subsequent reassembly.

e. Storage tanks need not be purged prior to disassembly or repair if the unit has not been out of service for an extended period (4 months or more), and the integrity of the unit has not been breached. However, if there is any reason to believe that the inner vessel or any of the piping has become contaminated, either through damage, carelessness or long-term storage, the unit must be drained and purged. See Section IV for purging procedures.

f. During disassembly and subsequent handling of components, exercise care to avoid any damage. Use particular care to avoid scratching or otherwise defacing flared-tube mating surfaces, flange faces and valve seats.

g. When empty the storage tank may be lifted with a common cable and slings, or with a fork lift, using the forklift slots provided in the skid assembly. Refer to Operation and Maintenance Instructions, T.O. 37C2-8-36-1, for further lifting and handling information.

h. Only tools most suited for the particular application may be used in disassembling the unit to prevent damage, distortion and breakage of parts.

i. Subassemblies removed intact (i.e. manifolds, valves, or piping assemblies) shall be supported in a suitable fixture, vise, or type of support during disassembly and subsequent reassembly.

j. Tag all parts for identification during disassembly. This will prevent the confusion of similar parts during reassembly.

k. Riveted, press-fit, and adhesive-attached (e.g. decals, nameplates) parts should not be removed except for replacement.

l. Remove and discard gaskets and preformed packings (O-rings) exposed during disassembly, as necessary. As a general rule, they should be replaced with new components at reassembly.

m. Remove all anti-seize tape from threaded fittings during disassembly. Remove all particles of the tape and take care that none enter the system.

3-3. DISASSEMBLY.

a. Storage tank must be totally drained before disassembly. If the storage tank contains a quantity of product measurable on the liquid level gage, pressure drain it in accordance with the procedures in Operation and Maintenance Instructions, T.O. 37C2-8-36-1.

b. If storage tank contains no measurable product (as indicated by the liquid level gage), make sure that no traces remain in tank. Remove all protective covers from all tank outlets and open the control valves.

c. When all product and gasses have been vented, perform the purging operations outlined in Section IV, as necessary. Refer to Paragraph 3-2, step e, to determine if purging is required.

3-3.1. Disassembly Procedures. Disassembly of the storage tank is generally in the order of the index numbers assigned in Figures 3-1 through 3-11 and as detailed in the following paragraphs. While the instructions outline the procedures for complete disassembly, this is not ordinarily desirable, necessary or practical to effect repairs. Disassemble the unit only to the extent required for the removal and replacement of defective parts. The orderly disassembly of the storage tank is as follows:

3-3.1.1. Service Hose Disassembly. (See Figure 3-1). The service hose provides the means by which the liquid product is transferred from the storage tank to the receiving vessel or service vehicle. Remove and disassemble as follows:

a. Lift the hose from the support in the cabinet; then, holding the hose, disconnect coupling to free hose of the service piping. Install dust plug on hose and caps on service line to prevent the entry of dust or moisture.

b. Holding the nipple (2) securely with a suitable wrench and gripping the coupling (3) with a spanner-type wrench, turn the coupling counter-clockwise until it is disconnected from the nipple.

c. If desired, further disassemble both couplings (3) by removing plug (4), removing the retaining ring (7), and separating the coupling nut (5) and coupling cone (6). Remove "S"-hook (8) and chain (9).

d. Holding the hose adaptor wrench flats with an appropriate wrench, and using a suitable wrench on nipple (2), turn the nipple counter-clockwise until separated from the hose. Do not attempt to remove hose adaptor fittings.

3-3.1.2. Globe Valve Disassembly (V-3 thru V-7, V-9). (See Figure 3-2). Access to components of the valve bonnet and stem assembly may be achieved by removing the handwheel and uncoupling the bonnet nut and lifting the bonnet and stem away from the valve body.

a. Open valve and remove handwheel nut (1) and remove handwheel (2).

b. Supporting the valve body (16) to prevent twisting, and using a suitable wrench, uncouple bonnet nut (6) from valve body and lift the stem and bonnet assembly away from body and cabinet.

c. Using suitable wrenches, and taking care not to damage components, turn packing nut (3) counter-clockwise until it is free of bonnet (7). Separate packing gland (4) from bonnet.

d. Holding the bonnet (7) stationary, turn the valve stem (14) clockwise until the threaded portion extends beyond the bonnet. The remainder may then be pulled through the bonnet and separated from it. This provides easy access to the packing set (5) which may now be extracted using a suitable hooked tool.

e. Holding the disc locknut (13) with an appropriate wrench, carefully disassemble, in sequence, the disc nut (8), disc plate (9), disc insert (10), disc holder (11), horseshoe ring (12) and disc locknut (13) from the stem (14).

f. Using the appropriate special tool, support the valve body (16) to prevent twisting and remove seat (15).

3-3.1.3. Globe Valve Disassembly (V-8). (See Figure 3-3). Access to components of the valve bonnet and stem assembly may be achieved by removing the handwheel and uncoupling the bonnet nuts (7) and lifting the bonnet and stem away from the valve body.

a. Open valve and remove handwheel nut

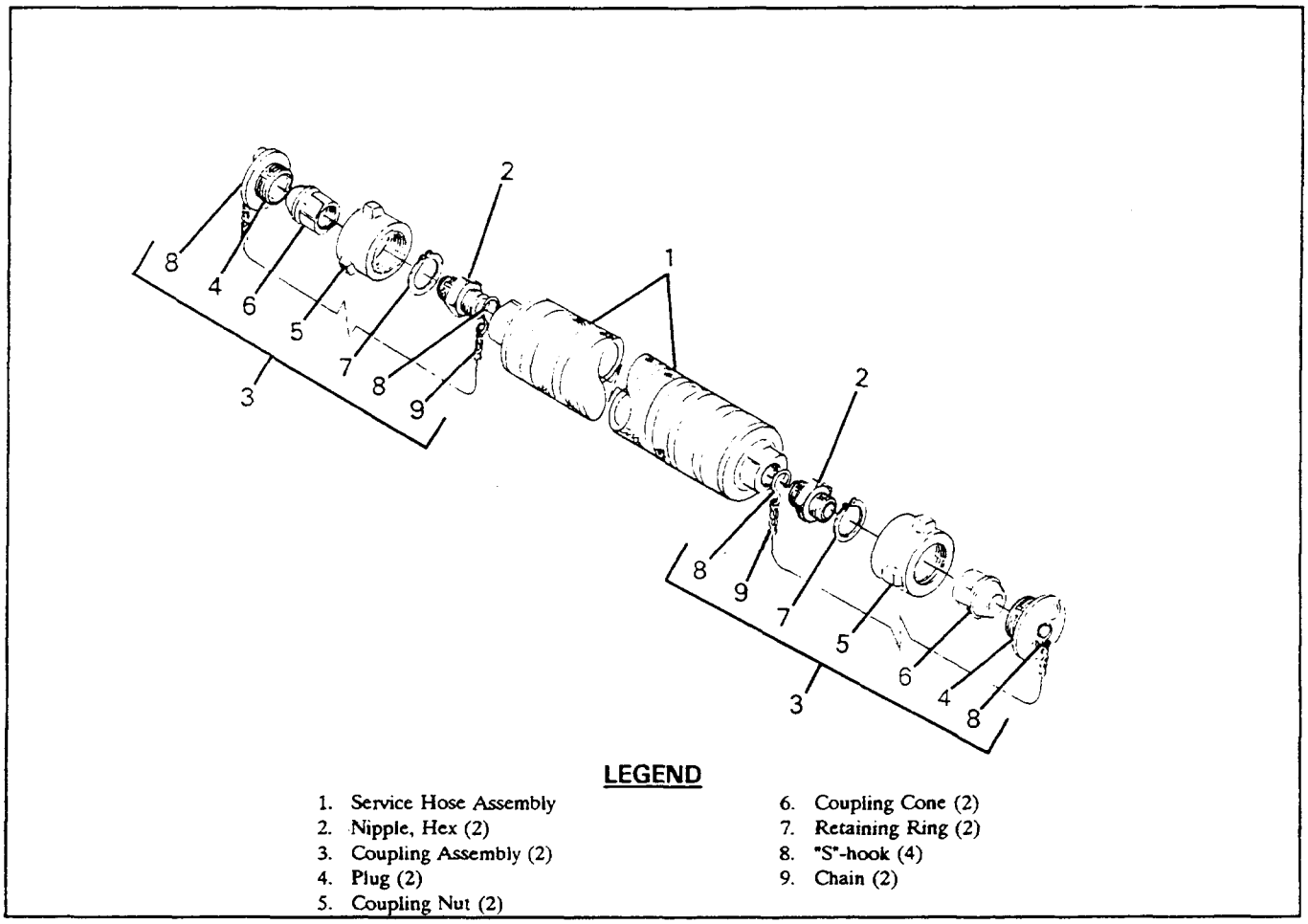


Figure 3-1. Service Hose Assembly

(1) and remove handwheel (2).

b. Remove nuts (7) from valve body studs (8) and lift stem and bonnet and stem assembly away from valve body. Remove plug assembly (17) from stem. Remove gasket (9).

c. Using suitable wrenches, and taking care not to damage components, turn packing nut (3) counter-clockwise until it is free of bonnet (6). Separate packing gland (4) from bonnet.

d. Holding the bonnet (6) stationary, turn the valve stem (14) clockwise until the threaded portion extends beyond the bonnet. The remainder may then be pulled through the bonnet and separated from it. This provides easy access to the packing (5) which may now be extracted using a suitable hooked tool.

e. Holding the disc holder (13) with an appropriate wrench, carefully disassemble, in sequence, the disc nut (10), disc plate (11), disc insert (12) from disc holder (13).

f. Using the appropriate special tool, support the valve body (16) to prevent twisting and remove seat (15).

3-3.1.4 PBU Assembly Disassembly. (See Figure 3-4). The PBU assembly may be removed and disassembled as follows:

a. Remove nuts (1), belleville washers (2), flat washers (3), flat washers (4) and screws (5). Remove gasket (6).

b. Remove nuts (8), belleville washers (9) and flat washers (10), flat washers (11) and screws (12). Remove gasket (13).

LEGEND

1. Nut
2. Handwheel
3. Packing Nut
4. Packing Gland
5. Packing Set
6. Bonnet Nut
7. Bonnet Assembly
8. Disc Nut
9. Disc Plate
10. Disc Insert
11. Disc Holder
12. Horseshoe Ring
13. Disc Locknut
14. Stem
15. Seat
16. Body

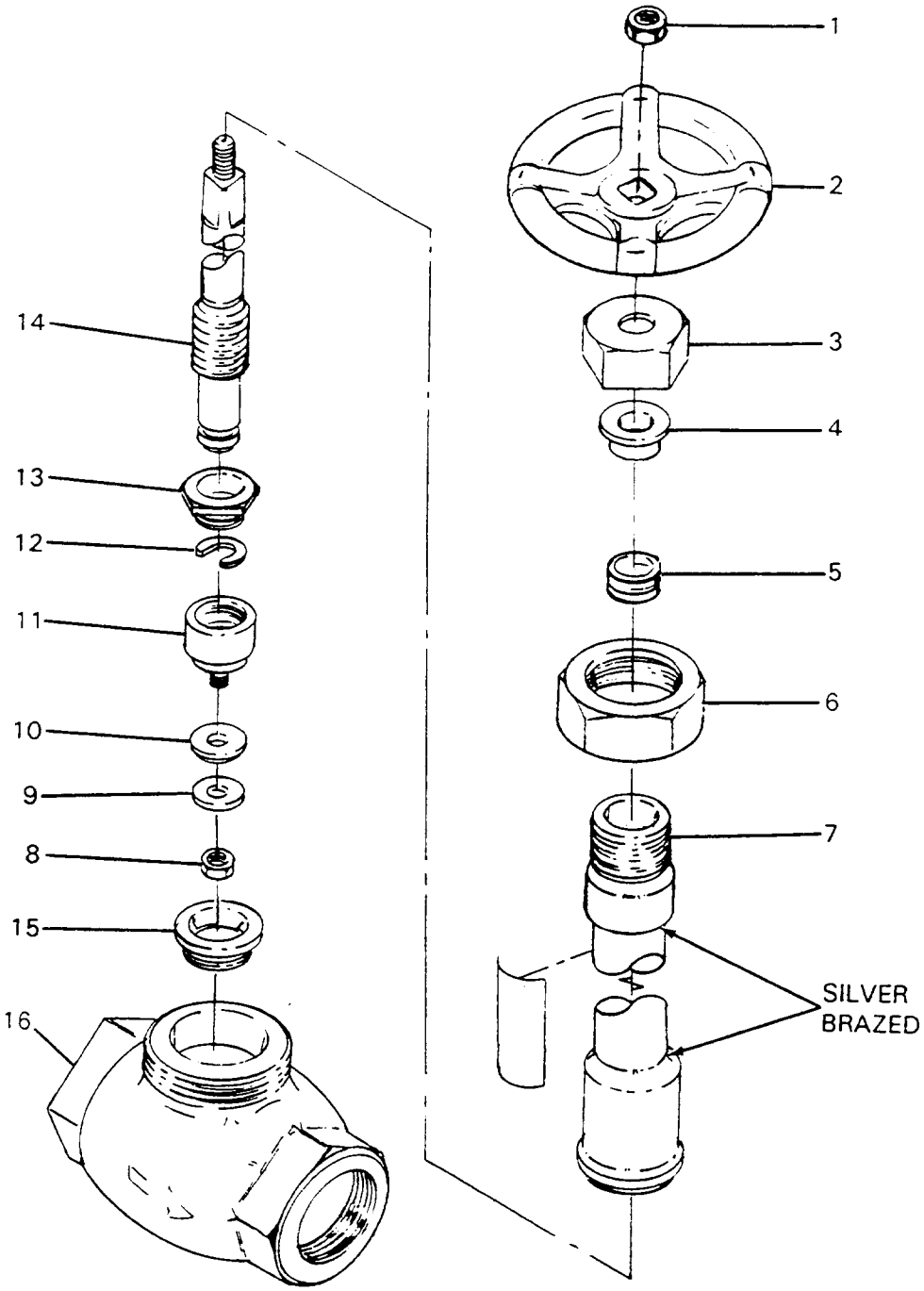


Figure 3-2. Globe Valve (V-3,V-4,V-5,V-6,V-7,V-9)

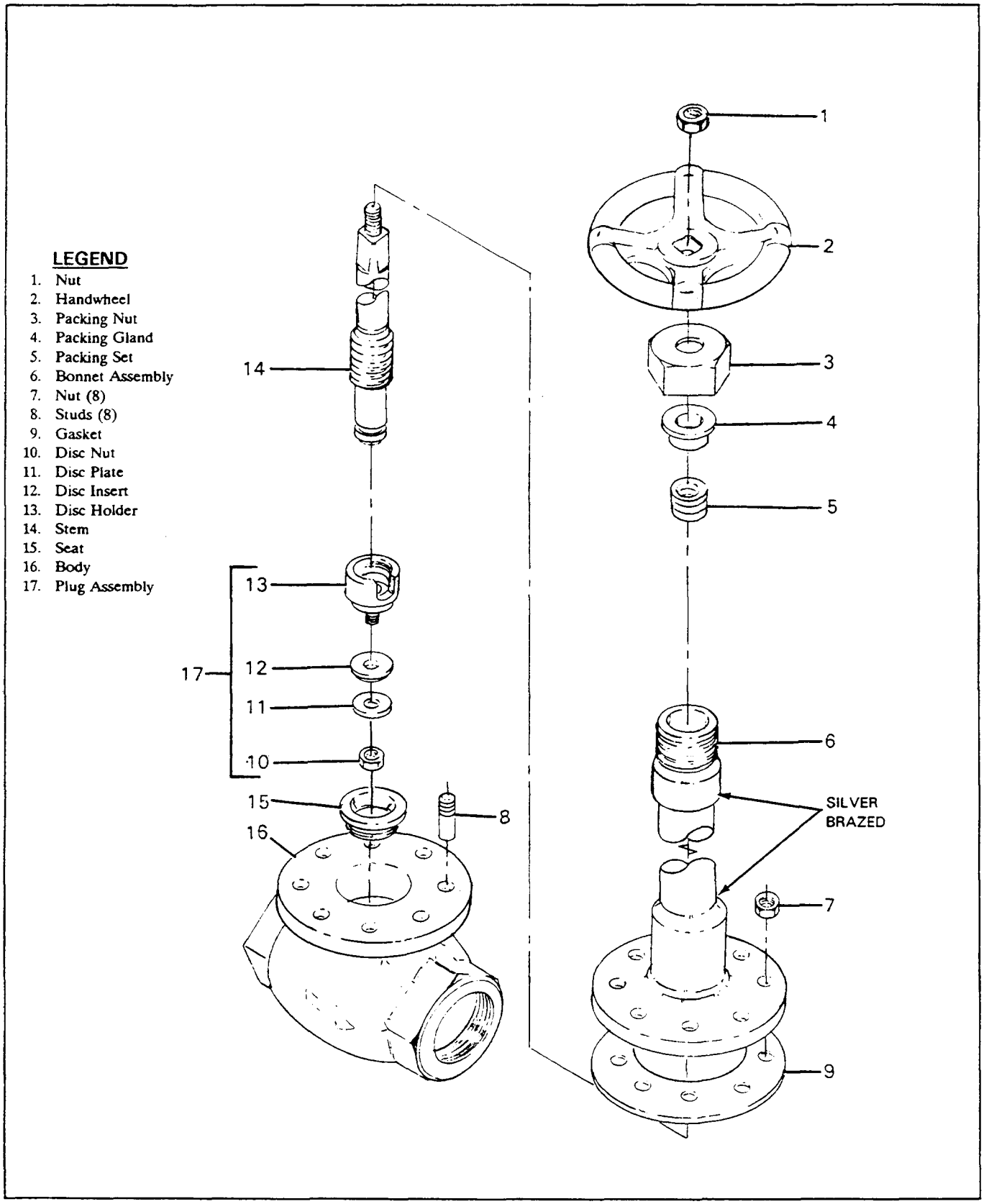
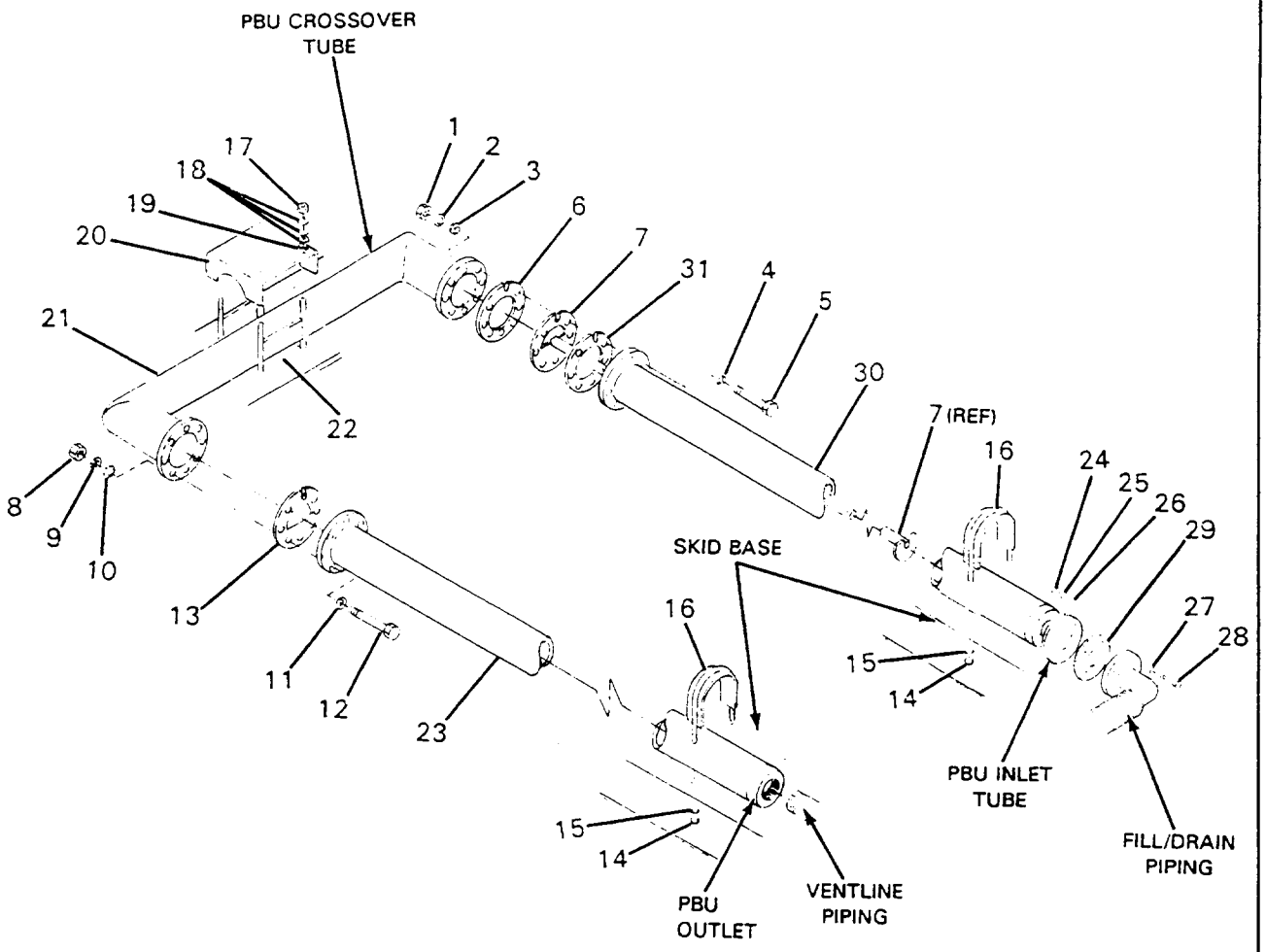


Figure 3-3. Globe Valve (V-8)



LEGEND

1. Nut (8)
2. Belleville Washer (8)
3. Flat Washer (8)
4. Flat Washer (8)
5. Screw (8)
6. Gasket
7. Baffle
8. Nut (8)
9. Belleville Washer (8)
10. Flat Washer (8)
11. Flat Washer (8)
12. Screw (8)
13. Gasket
14. Nut (4)
15. Washer (4)
16. Clamp (2)
17. Nut (4)
18. Belleville Washer (12)
19. Flat Washer (4)
20. Bracket
21. Crossover Tube
22. Insulator
23. Tube, Outlet
24. Nut (4)
25. Belleville Washer (4)
26. Flat Washer (4)
27. Flat Washer (4)
28. Screw (4)
29. Gasket
30. Tube, Inlet
31. Gasket

Figure 3-4. PBU Assembly

c. Remove nuts (14) and washers (15) from clamps (16) on inlet tube (30) and outlet tube (23). Remove clamps (16).

d. Remove nuts (17), belleville washers (18) and flat washers (19) from studs on frame. Remove rear bracket (20).

e. Remove PBU crossover tube (21), remove baffle (7) and gasket (31).

f. Remove insulator (22).

g. Using wrench to hold vent piping, unscrew outlet tube (23) and remove from vent piping assembly.

h. Remove nuts (24), belleville washers (25), flat washers (26), flat washers (27) and screws (28). Remove gasket (29).

i. Remove inlet tube (30) from fill/drain piping.

3-3.1.5 Instrument Panel Disassembly. (See Figure 3-5). The instrument panel assembly consists of the liquid level gage (LL-1), pressure gage (PI-1), isolation valve (V-10), and associated piping and components. Remove and disassemble the instrument panel as follows:

a. Loosen tube nuts on both ends of tubes (1) and remove tubes.

b. Remove nuts (2), washers (3) and screws (4). Panel (32) may now be lifted out of cabinet.

c. Loosen tube nuts on tubes (5,6,7,8,9) and remove tubes and isolation valve (10) and two tees (11).

d. Remove elbow (12) from pressure gage (13) and elbows (14,15) from liquid level gage (16).

e. Remove cap (18), locknut (20) and union (19).

f. Remove cover (21) from pressure gage (13).

g. Remove nuts (22), screws (23) and remove pressure gage (13) from panel (32).

h. Remove screws (24) and remove cover (25) from liquid level gage (16).

i. Remove nuts (26), screws (27) and remove liquid level gage (16).

j. Remove nameplates (28,29,30) by removing two rivets (31) from each nameplate.

3-3.1.6. Vent Line Disassembly. (See Figure 3-6). The vent piping assembly consists of relief valve (RV-3), rupture disc (SD-1), globe valve (V-8) and associated piping components. Relief valve (RV-3) is not field repairable and should be replaced with a new valve if found to be defective. If globe valve (V-8) is found to be defective, see paragraph 3-3.1.3. Remove and disassemble the vent piping assembly as follows:

a. Remove pipe (1) and valve (2) from pipe assembly (3).

b. Remove elbow (4), pipe (5), rupture disc (6) and pipe (7) from pipe assembly (3).

c. Remove nuts (8), washers (9) and screws (10) and remove gasket (11) and pipe (12) from pipe assembly (13). Pipe assembly (13) is welded to tank and cannot be removed. Before removing pipe assembly (12), the left side of the PBU must be removed per paragraph 3-3.1.4.

d. Remove nuts (27) and screws (26) and remove spacer (25).

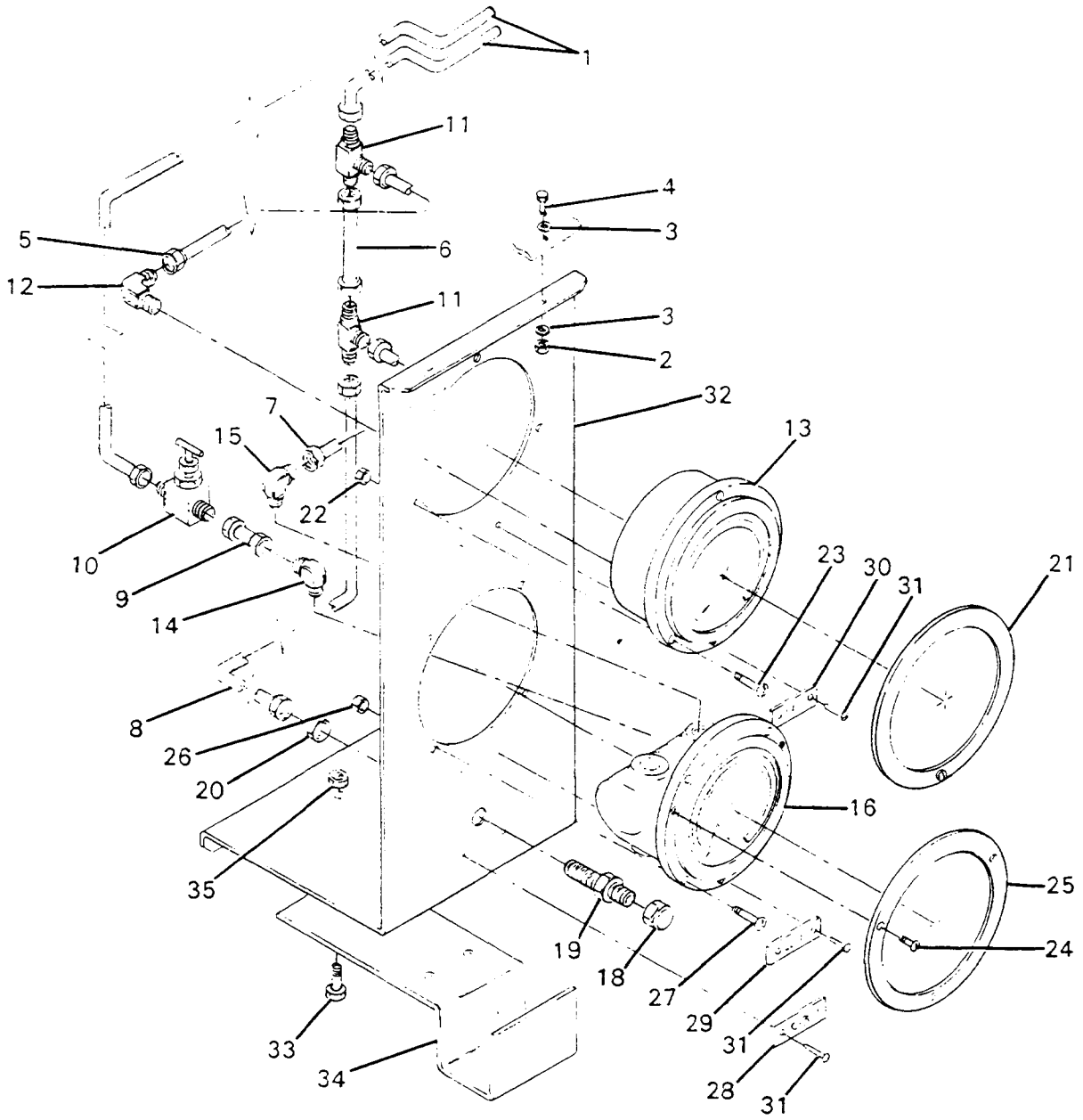
e. Remove coupling (14) and pipe (15) from valve (16).

f. Remove nuts (17) and tag bracket (18) from valve (16). Nametag (19) can be removed by removing rivets (20).

g. Remove bonnet and stem assembly from valve (16) per paragraph 3-3.1.3. Valve body can now be removed from pipe assembly (3).

h. Remove nuts (21), washers (22) and screws (23) and remove gasket (24) and pipe assembly (3) from pipe assembly (13).

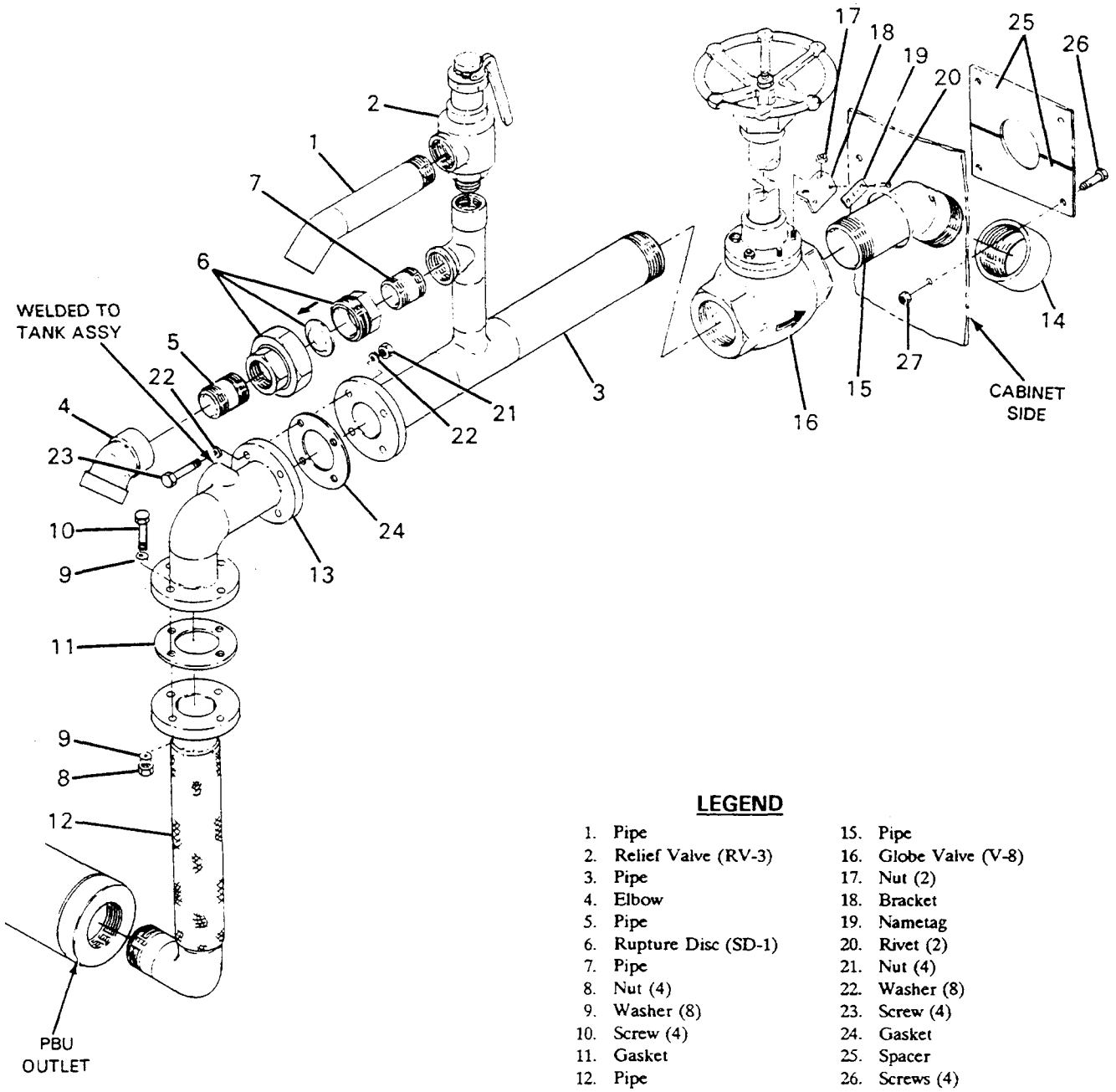
3-3.1.7 Service Line Disassembly. (See Figure 3-7). The service line consists of relief valve (RV-1), two globe valves (V-3, V-4), filter (F-1) and associated



LEGEND

1. Tube (2)
2. Nut (4)
3. Washer (8)
4. Screw (4)
5. Tube
6. Tube
7. Tube
8. Tube
9. Tube
10. Valve (V-10)
11. Tee (2)
12. Elbow
13. Pressure Gage (PI-1)
14. Elbow
15. Elbow
16. Liquid Level Gage (LL-1)
17. (Deleted)
18. Cap
19. Union
20. Locknut
21. Cover
22. Nut (3)
23. Screw (3)
24. Screw (3)
25. Cover
26. Nut (4)
27. Screw (4)
28. Nameplate
29. Nameplate
30. Nameplate
31. Rivet (6)
32. Panel
33. Screw (3)
34. Bracket
35. Nut (3)

Figure 3-5. Instrument Panel



LEGEND

1. Pipe
2. Relief Valve (RV-3)
3. Pipe
4. Elbow
5. Pipe
6. Rupture Disc (SD-1)
7. Pipe
8. Nut (4)
9. Washer (8)
10. Screw (4)
11. Gasket
12. Pipe
13. Pipe
14. Coupling
15. Pipe
16. Globe Valve (V-8)
17. Nut (2)
18. Bracket
19. Nametag
20. Rivet (2)
21. Nut (4)
22. Washer (8)
23. Screw (4)
24. Gasket
25. Spacer
26. Screws (4)
27. Nut (4)

Figure 3-6. Vent Line

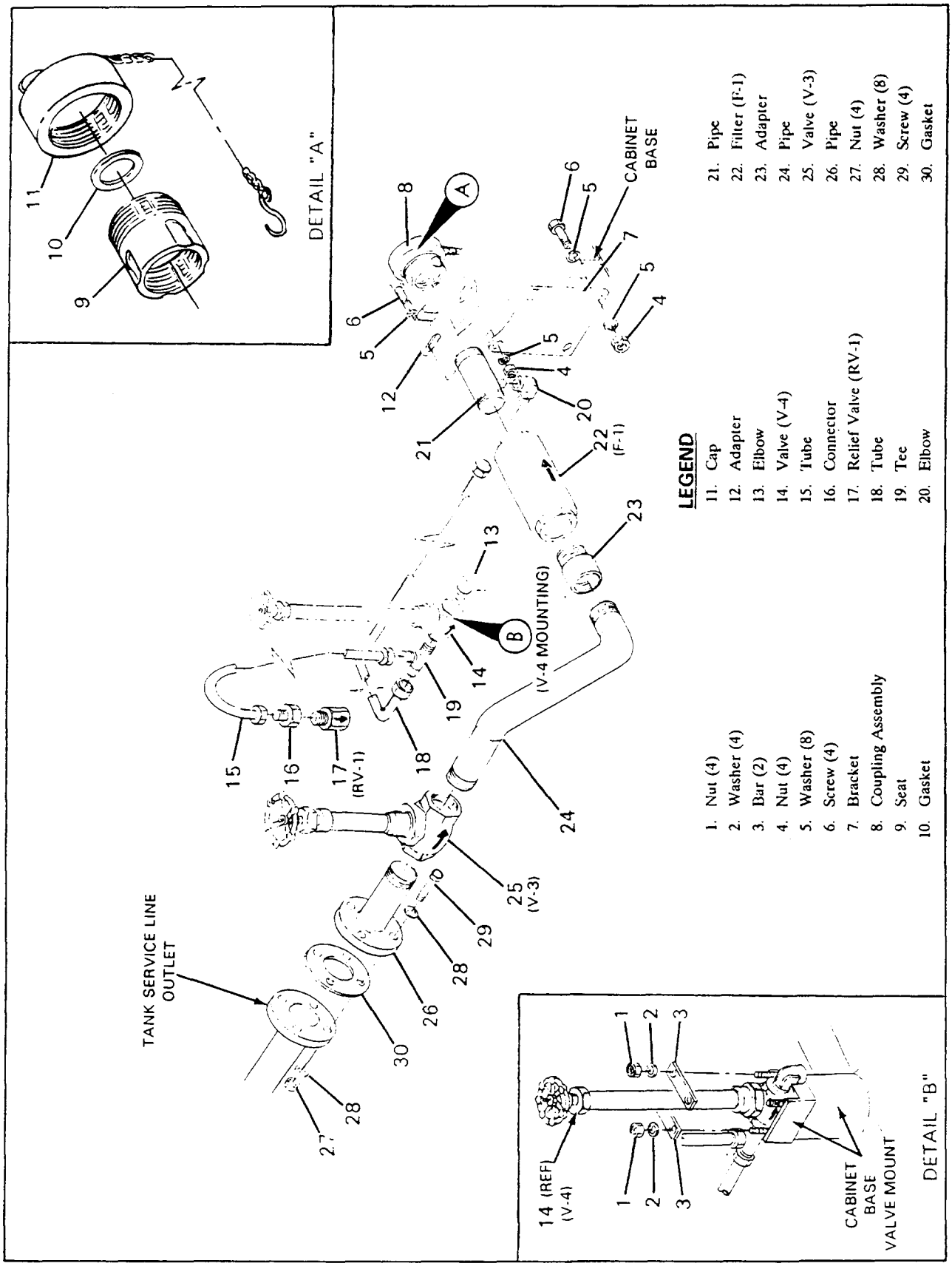


Figure 3-7. Service Line

piping components. Disassemble the service line as follows:

a. Remove stem and bonnet assembly from valves (V-3) and (V-4) per paragraph 3-3.1.2.

b. Remove tube (18) by loosening nuts on tee (19) and elbow (20).

c. Loosen tube nut on tube (15) and remove tube (15) from tee (19). Remove valve RV-1 (17) from connector (16) and remove connector (16) from tube (15).

d. Remove nuts (1), washers (2) and valve mounting bars (3) from around valve (14).

e. Remove valve body (14) and remove tee (19) and elbow (13) from valve body (14).

f. Remove nuts (4), washer (5), and screws (6). Remove bracket (7).

g. Remove coupling assembly (8). Remove bracket (12), elbow (20), pipe (21), filter (22) and adapter (23).

h. Coupling (8) may be disassembled by removing cap (11) and gasket (10) from seat (9).

i. Remove nuts (27), washers (28), screws (29), and gasket (30). Remove subassembly (24,25,26).

j. Remove pipe (26) and pipe (24) from valve body (25).

3-3.1.8. **Fill/Drain Line Disassembly.** (See Figure 3-8). The fill/drain consists of relief valve (RV-2), globe valves (V-5, V-6, V-7), filter (F-2) and associated piping components. Remove and disassemble the fill/drain line as follows:

a. Remove stem and bonnet assemblies from valves (V-5), (V-6) and (V-7) per paragraph 3-3.1.2.

b. Remove tube nuts on tubes (1,2) and remove tubes.

c. Remove valve (4) and connector (3) from tube (1).

d. Remove tee (5) from valve (6).

e. Remove nuts (7), washers (8) and bars (9) and remove valve body (6) and elbow (10).

f. Remove nuts (11), washers (12) and screws (13). Remove gasket (41).

g. Remove nut (14), washers (15) and screws (16). Remove gasket (17).

h. Remove nuts (18), washers (19) and screws (20) from bracket (21) and remove bracket.

i. Assembly may now be lifted out of cabinet for disassembly.

j. Remove nuts (22), flat washers (42), belleville washers (23), screws (24), gasket (40) and remove pipe (25) from PBU.

k. Remove coupling assembly (26). Coupling assembly may be disassembled by removing cap (29) and gasket (28) from seat (27).

l. Remove adapter (30) from elbow (31).

m. Remove elbow (31), pipe (32) and filter (33).

n. Remove elbow (34) and pipe (35) from valve (36). Remove valve body (36).

o. Remove pipe (37) and valve body (38) from pipe (39).

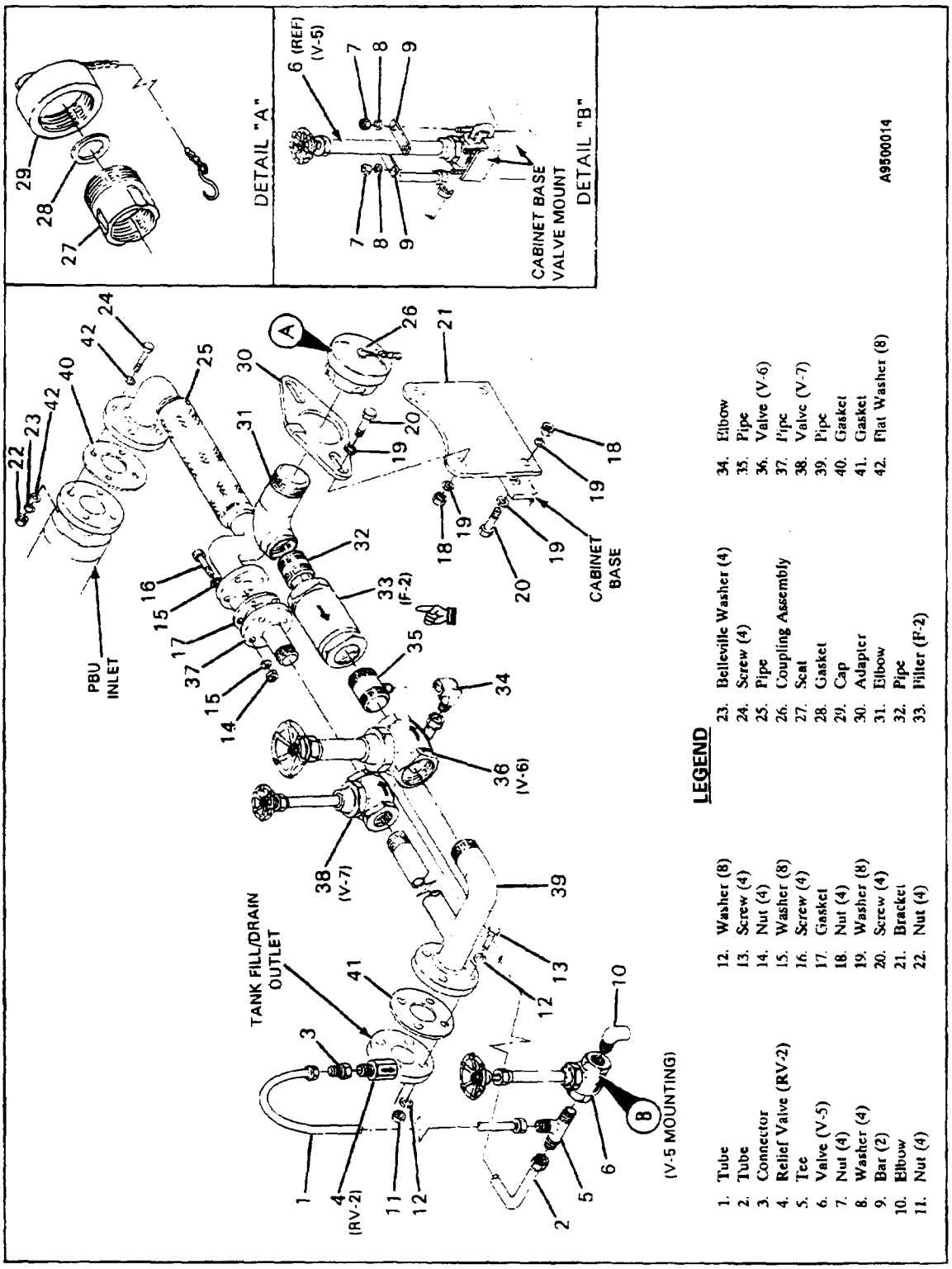
3-3.1.9. **Cabinet Disassembly.** (See Figure 3-9). The cabinet assembly is attached to the bottom base with screws and nuts. The top and side panels are also attached with screws and nuts. Although it is not practical to remove the cabinet assembly, some replaceable components may be removed as follows:

a. Remove cabinet top (1) by removing 11 nuts (2) and screws (3).

b. Remove left door (19) by removing 17 nuts (20) and screws (21) from hinge (22).

c. Remove hinge (22) by removing 18 nuts (23) and screws (24) from cabinet (75).

d. Remove right door (50) by removing 17



LEGEND

1. Tube
2. Tube
3. Connector
4. Relief Valve (RV-2)
5. Tee
6. Valve (V-5)
7. Nut (4)
8. Washer (4)
9. Bar (2)
10. Elbow
11. Nut (4)
12. Washer (8)
13. Screw (4)
14. Nut (4)
15. Washer (8)
16. Screw (4)
17. Gasket
18. Nut (4)
19. Washer (8)
20. Screw (4)
21. Bracket
22. Nut (4)
23. Belleville Washer (4)
24. Screw (4)
25. Pipe
26. Coupling Assembly
27. Seal
28. Gasket
29. Cap
30. Adapter
31. Elbow
32. Pipe
33. Filter (F-2)
34. Elbow
35. Pipe
36. Valve (V-6)
37. Pipe
38. Valve (V-7)
39. Pipe
40. Gasket
41. Gasket
42. Flat Washer (8)

Figure 3-8. Fill/Drain Line

nuts (51) and screws (52) from hinge (72).

e. Remove hinge (72) by removing 18 nuts (73) and screws (74) from cabinet (75).

f. Remove 4 keepers (13) by removing nuts (14) and screws (15).

g. Remove pawl brackets (31,32) by removing nuts (33) and screws (34). Remove pawl (35).

h. Remove 2 door bars (36) by removing cotter pins (37) and screws (38).

i. Remove handle (39) by removing nuts (40) and screws (41).

j. Remove latch (45) by removing nuts (46) and screws (47).

k. Remove 2 brackets (42) by removing nuts (43) and screws (44).

l. Placards and nameplates can be removed by drilling out rivets that attach them.

3-3.1.10. Thermocouple and Vacuum Gage Valve Removal and Disassembly. (See Figure 3-10). The thermocouple and vacuum gage valve are not normally removed or disassembled. Instructions are included only to offer a means of repair in case of damage.

a. The vacuum gage (thermocouple isolation) valve (V-2) must not be removed from the storage tank unless the annular space has been filled with dry nitrogen gas (See Section V). Replacement of the valve should only be considered in the case of failure to operate properly or leakage. Do not attempt repairs until the annular space has been filled with dry nitrogen gas.

b. With the vacuum gage (thermocouple isolation) valve (2) closed, unscrew the thermocouple gage tube (1) from the vacuum gage valve (2).

c. Using a suitable wrench, turn the valve body counter-clockwise until it is free of the tank fitting. Remove any traces of old vacuum sealing compound to prevent any particle of it from entering the tank when it is evacuated. Make sure that the tank fitting is covered at all times when the valve is removed to prevent the entry of dust or moisture.

3-3.1.11. Vacuum Line Shut-off Valve Disassembly. (See Figure 3-11). The vacuum line shut-off valve (V-1) is not normally disassembled as a matter of routine maintenance. Instructions are offered only to offer a means of removal and replacement of parts following valve failure. Do not attempt repairs until the annular space has been filled with dry nitrogen gas.

a. Remove nuts (9) and washers (10) from studs on tank. Remove valve (11) and o-ring (12) from tank.

b. Remove nuts (1) and washers (2) from top studs on adapter (4). Remove flange (3) and o-ring (5).

c. Remove nuts (6) and washers (7) from bottom studs on adapter (4). Remove adapter (4) and o-ring (8).

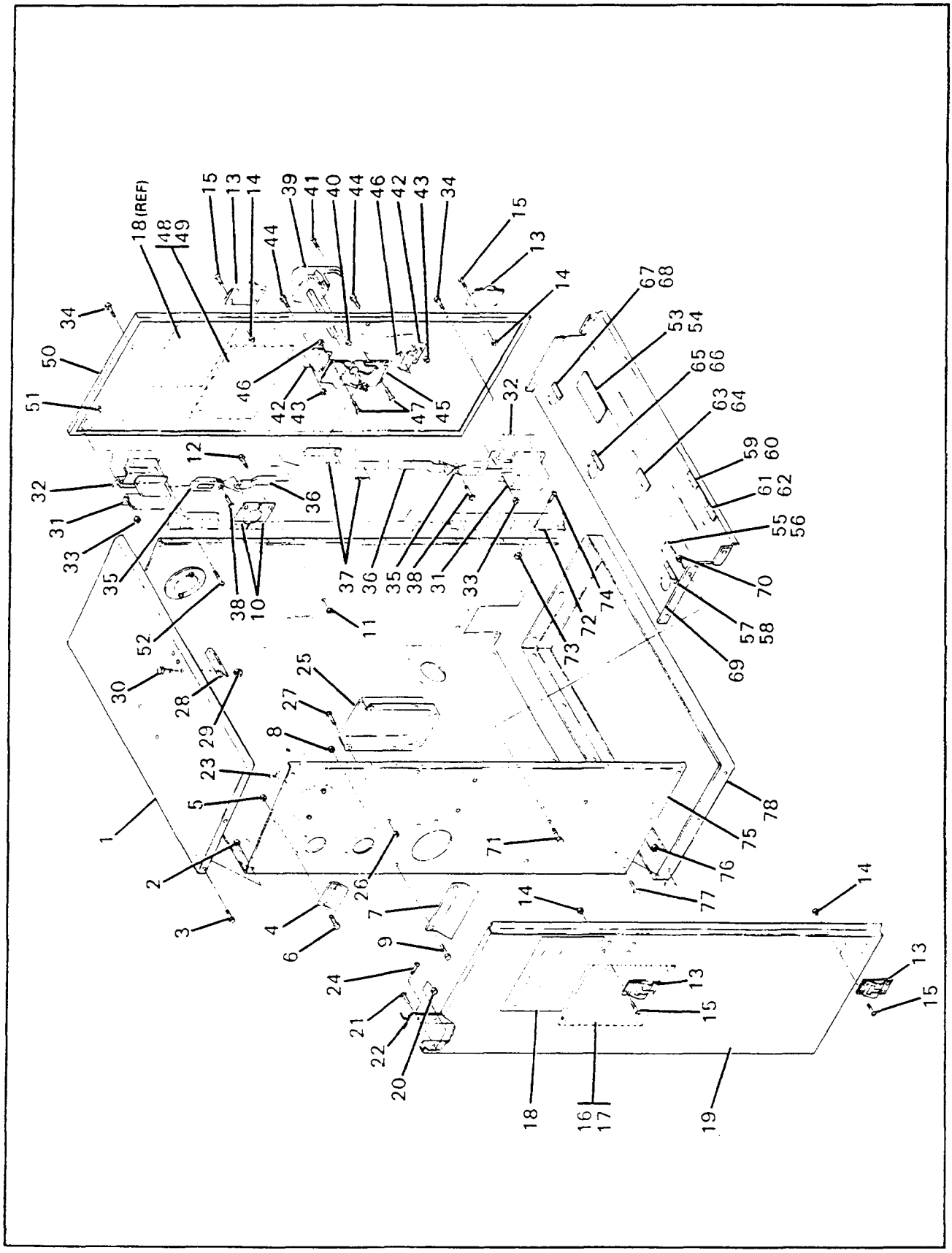
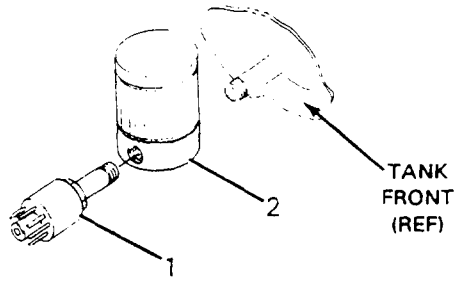


Figure 3-9. Cabinet

LEGEND

1. Cabinet Top
2. Nut (11)
3. Screw (11)
4. Shield (7)
5. Nut (14)
6. Screw (14)
7. Shield (2)
8. Nut (4)
9. Screw (4)
10. Spacer (2)
11. Nut (4)
12. Screw (4)
13. Keeper (4)
14. Nut (16)
15. Screw (16)
16. Operation Plate
17. Rivet (6)
18. Decal
19. Left Door
20. Nut (17)
21. Screw (17)
22. Hinge
23. Nut (18)
24. Screw (18)
25. Manual Holder
26. Nut (6)
27. Screw (6)
28. Door Stop
29. Nut (3)
30. Screw (3)
31. Bracket (2)
32. Bracket (2)
33. Nut (8)
34. Screw (8)
35. Pawl (2)
36. Bar (2)
37. Cotter Pin (2)
38. Screw (2)
39. Handle
40. Nut (3)
41. Screw (3)
42. Bracket (2)
43. Nut (4)
44. Screw (4)
45. Latch
46. Nut (4)
47. Screw (4)
48. Nameplate
49. Rivet (4)
50. Right Door
51. Nut (17)
52. Screw (17)
53. Insulation Data Plate
54. Rivet (4)
55. Warning Plate
56. Rivet (4)
57. Nameplate (V-3)
58. Rivet (2)
59. Nameplate (V-4)
60. Rivet (2)
61. Nameplate (V-5)
62. Rivet (2)
63. Nameplate (V-6)
64. Rivet (2)
65. Nameplate (V-7)
66. Rivet (2)
67. Nameplate (V-9)
68. Rivet (2)
69. Valve Panel
70. Nut (6)
71. Screw (6)
72. Hinge
73. Nut (18)
74. Screw (18)
75. Cabinet
76. Nut (11)
77. Screw (11)
78. Cabinet Base

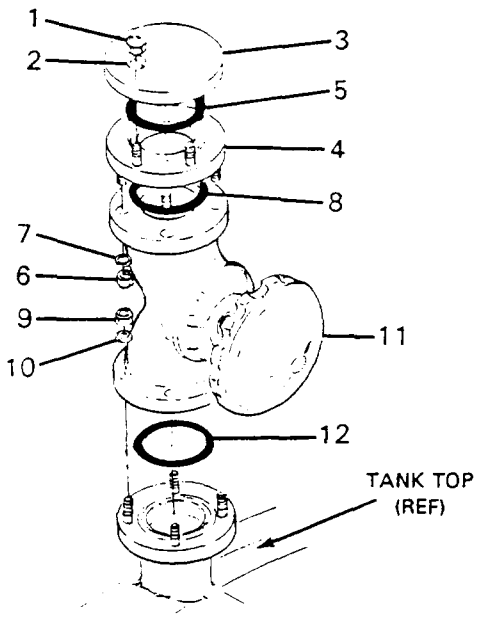
Figure 3-9. Cabinet (CONT.)



LEGEND

1. Thermocouple Gage Tube
2. Vacuum Gage (Thermocouple Isolation) Valve

Figure 3-10. Thermocouple and Vacuum Valve Assembly



LEGEND

1. Nut (4)
2. Washer (4)
3. Flange
4. Adapter
5. O-ring
6. Nut (4)
7. Washer (4)
8. O-ring
9. Nut (4)
10. Washer (4)
11. Valve (V-1)
12. O-ring

Figure 3-11. Vacuum Line Shut-off Valve

SECTION IV
CLEANING

4-1. SCOPE.

This section contains special procedural instructions for the cleaning of the storage tank, its subassemblies and components. Procedures are presented for parts as they were removed following the instructions in Section III.

4-2. PRECAUTIONS.

Cleanliness and handling procedures shall be in accordance with those outlined in Section III, Paragraph 3-2. Personnel shall use gloves and face shields, as necessary, when using solvents. Components which will come in contact with liquid product shall be plugged and bagged after cleaning, and shall remain so until reinstalled.

CAUTION

Never use shop compressed air to dry cleaned parts, hose assemblies or connecting fittings. Always use clean, dry, water-pumped gaseous nitrogen, Type BB N 411, for purging and drying.

a. Clean the external surfaces of the storage tank and exposed surfaces inside the control housing with a mild detergent and warm water. Wipe dry with a clean, lint-free cloth. Do not use extremely hot water or steam.

b. Clean parts with clean liquid trichlorotrifluoroethane (freon). Ultrasonic cleaning with approved solvents is also acceptable, as applicable. Dry cleaned parts by purging with dry, water-pumped gaseous nitrogen, Type BB N 411. After cleaning and drying, inspect parts under ultraviolet light (Refer to Section VII). Any evidence of florescence will require recleaning and repetition of the ultraviolet examination.

CAUTION

Allow only a slight flow of gas when drying instruments. Excessive flow will damage instrument sensing elements.

c. Filter Cleaning. To remove hydrocarbon and/or particulate contamination, immerse filter in trichlorotrifluoroethane (freon). With unused trichlorotrifluoroethane (freon) back flush filter to remove all contamination. Flush filter with demineralized water and blow dry with nitrogen gas, Type BB-N-411. Perform odor test and check for contamination using ultraviolet light. To remove large particulate contamination, tap filter on the inlet port side with sufficient force to remove particles. Use a flat surface and ensure to not damage filter body and repeat filter cleaning until particle contamination is removed. If filter remains clogged after cleaning, it should be discarded.

4-3. PURGING.

Purging is the process of forcing heated air or nitrogen through the drained storage tank, causing residual product and any contaminants which have entered the tank to be converted to a gaseous state and be expelled. Contaminants, present in the product, are normally gasses in the air and reduced to a solidified state as the product is prepared. These contaminants tend to settle in the tank sump, so that concentration increases with tank use. When the concentration reaches an undesirable level, as determined by laboratory or odor tests, the storage tank must be drained and purged.

4-3.1. Frequency of Purging. LOX tanks shall be drained and purged as indicated in the Work Cards T.O. 37C2-8-1-116WC-1 or whenever impurities exceed the use limits established in T.O. 42B6-1-1. This T.O. specifies that whenever contamination is suspected, a sample of the product shall be sent to a designated laboratory for contamination testing. The liquid oxygen sampler model FSC2001 or equivalent is required for this purpose. Analysis of the results of the test shall be used by the base Fuels Officer to determine if purging is required. When contamination is authenticated the source tank shall be purged to ensure complete disposal of contaminants.

4-3.2. Procedures. Purging procedures will be accomplished according to the following steps:

a. Portable tanks used to receive contaminated product must also be purged to ensure complete disposal.

b. Ensure storage tank has been drained prior to purging. If not, reference draining procedures in T.O. 37C2-8-36-1.

c. Open vapor vent line shut-off valve (V-8), all other valves are closed.

d. Ensure tank plumbing and filters are at ambient temperature before removal of any components.

e. Remove filters and disconnect tubing to pressure gage and liquid level gage, if applicable.

NOTE

The GSU-62/M purging unit or equivalent is required to purge tanks.

f. Position GSU-62/M purging unit next to tank vapor vent line shut-off valve (V-8). Connect purging unit to source of 220/440 volt, 3-phase, 60 cycle AC power outlet.

g. Connect necessary purge unit adapter to tank vent line.

h. Connect purge unit discharge hose to tank vent line, and attach temperature gage to fill line outlet.

i. Open fill/drain valve (V-6).

CAUTION

Do not allow the temperature of the air exiting the tank to rise above 220°F to prevent possible damage to the tank.

j. Start and operate purging unit following instructions given in T.O. 36G2-3-1. Continue to operate unit and monitor temperature gage at fill line outlet, until the temperature of 220°F is attained. The temperature of 220°F can be maintained at the outlet by cycling the purge unit heater switch off and on as necessary.

WARNING

All metal tubing and valves on tank will become hot, contact with hot plumbing will result in burns.

k. Alternately open and close all other valves to assure hot air flows through all plumbing and lines.

NOTE

The 220°F tank outlet temperature is the preferred temperature at which a tank should be purged. However, if conditions do not permit attainment of that temperature, the technician will reach the highest temperature possible and then continue purging for that period of time stated in Table 4-1.

l. Operate the purging unit at the maximum attainable temperature at the fill/drain outlet for the time specified in Table 4-1.

m. When purging time is completed, turn off purge unit heater switch. Continue air flow into inner tank until fill line outlet temperature gage has cooled to 150°F. This will prevent cooling gases from later causing a vacuum to occur in the inner tank and drawing in atmospheric air and moisture into the inner tank if a valve is opened.

n. Close all valves, turn off and disconnect purge unit service hose and adapters from tank and reposition purge unit away from the area.

o. Reconnect all tubing to instruments and install cleaned filters.

p. Service the tank with product in accordance with T.O. 37C2-8-36-1. Service pressure shall not exceed 10 psig to minimize thermal shock to the inner shell.

Table 4-1. Purging

Maximum Temperature (°F)	Purging Time (Hours)
220	4
210	6
200	8
190	12
180	16
170	24
160	32
150	48
140	64

SECTION V
INSPECTION, REPAIR AND REPLACEMENT

5-1. SCOPE.

This section presents the necessary instructions for inspection and replacement of storage tank components. In addition to normally accepted mechanical procedures for repair and replacement, this section contains directions for breaking the vacuum, evacuation of the annular space between the inner and outer vessels, leak detection, and the painting of the tank exterior.

5-2. SPECIAL TOOLS AND TEST EQUIPMENT.

The special tools and test equipment required for the performance of the tasks and procedures described in this section are listed in Table 2-1.

5-3. SPECIAL MATERIALS.

The special materials required to perform the procedures in this section are listed in Table 2-2.

5-4. INSPECTION.

Periodic inspections are performed in accordance with T.O. 37C2-8-1-116WC-1, Periodic Inspection Work Cards. However, operating and maintenance personnel must be aware of discrepancies. The performance of an informal inspection on a monthly basis is highly recommended. During general inspections, check the following:

a. Check the control housing and panels for dents, missing screws, rivets, and washers. Pay particular attention to scraped and missing paint, and other damage.

b. Check the indicating instruments for cracked or broken glass, bent or damaged pointers, loose or damaged couplings or mountings, and moisture in gages.

c. Check all valves for general condition, smooth and positive action. Do not check the vacuum indicator (thermocouple isolation) valve (V-2). Any frosting on a valve or piping is an indication of a possible leak.

d. Check all tubing for looseness, bending, dents or other damage.

e. Check all tank markings and decals for legibility, scratches, looseness, and damage. Damaged decals must be replaced.

f. Check exterior of the storage tank for chipped paint, dents and deformation. Pay particular attention to areas around the forklift tubes and the hoisting and tiedown rings.

g. Check the service hose and its flexible windings for excessive wear. Inspect fittings for thread wear and physical damage.

h. Inspect the fill/drain coupling assembly for damaged or missing coupling cap, gasket, or safety chain. Pay particular attention to coupling seat threads, inspecting for possible damage.

i. Check the overboard vent line, making sure that there are no obstructions (plugs, caps, external blockage) if there is any product in the tank. A polyethylene bag or tape is permitted to exclude dust and moisture, if the tank is in dry storage.

j. Check the general condition of all assemblies, inspecting for loose or missing hardware. Make sure that all flange bolts and fittings are tight.

k. Inspect for general cleanliness. If there is any doubt about hydrocarbon contamination around fittings, or evidence of corrosion products, metal chips, grease, paint, preservatives or any other foreign matter around any area which could be contacted by the product, conduct an ultra-violet light cleanliness test (para. 5-6). Evidence of contamination or foreign matter will indicate that lox cleaning is required (See Section IV), followed by a repetition of this test.

5-5. PERIODIC INSPECTION.

Complete periodic inspections are performed in accordance with, and at the intervals indicated by T.O. 37C2-8-1-116WC, Periodic Inspection Work Cards.

5-6. CLEANLINESS INSPECTION.

Cleanliness must become an established habit for all personnel associated with the operation and maintenance of the storage tank. The exterior and interior of the unit must meet established criteria for cleanliness which are designed to protect the tank itself, the equipment it services, and the personnel who operate and maintain it. Any discrepancies must be noted and corrected at once. Inspections are as follows:

5-6.1. Exterior Inspection. Make sure that the tank exterior is free of contamination by performing the following steps:

a. Visually inspect for evidence of oils, greases, metal chips and scaling.

b. Using ultraviolet light, check ports, couplings, vapor vent, around service and fill piping, and all of the surrounding areas for evidence of hydrocarbons. Clean any fluorescent areas and remove any fluorescent particles.

5-6.2. Interior Inspection. Perform interior cleanliness inspections only after major overhauls, when contamination is suspected, and before a storage tank is placed in service after long term dry storage. Interior inspection may be performed through the manway or by performing the following procedures. Do not perform the interior cleanliness test unnecessarily, as it involves filling the tank 90% full of liquid oxygen. Filter (F-2) must be removed before performing this procedure (See paragraph 3-3.1.8.). Conduct the test as follows:

a. Fill the storage tank to 90% of its design capacity with pre-filtered liquid oxygen. Accomplish filling through both the fill/drain coupling and service line.

b. Allow the storage tank to stabilize, undisturbed, for a minimum of two (2) hours.

c. Obtain a Millipore membrane filter (See Table 2-1), weight it, record the weight; and, then place the filter in a Millipore filter holder (See Table 2-1).

d. Remove the protective cap from the drain line, attach filter holder in its place.

e. Using a suitable dewar to receive the liquid oxygen discharged through the filter holder, open the drain valve (V-6), and allow at least one (1) liter of product to pass through the line and filter.

f. Detach the filter holder and remove the filter element. Dry the filter thoroughly, and examine it for particulate matter and total solids by weighing and visual examination with a calibrated loupe.

(1) No total solid with a dimension greater than 1000 microns will be allowed.

(2) No fibrous particle with a length greater than 6000 microns will be allowed.

(3) No more than 25 milligrams of both solid and fibrous particles will be allowed.

g. If the total material, solid and fibrous, exceeds the above specified requirements, the remaining liquid will be discharged through drain line and the storage tank flushed with liquid oxygen until the total amounts of foreign material fall within the above outlined criteria.

h. Install filter (F-2) (See paragraph 6-4.1.4).

5-7. REPAIR AND REPLACEMENT.

Most repairs consist of removal and replacement of worn or damaged parts, as determined by visual inspection. Special instructions are presented in the following paragraphs for individual components. Some inspection notes are included with the instructions to clarify the need or facilitate the replacement procedures. Replace all items determined by inspection to be unserviceable. In general, these rules may be followed:

5-7.1. Threaded Components. If threads are nicked, but not deformed, they may be re-threaded, using suitable taps and dies. Small nicks may be chased with a small file.

5-7.2. Nuts. File deformed or nicked wrench flats to proper contours if the nut itself is not deformed.

5-7.3. Corrosion. Remove corrosion by sanding lightly with a light grade of sandpaper or emery cloth.

5-7.4. Gaskets, Preformed Packings (O-Rings). Replace all damaged and worn gaskets and preformed packings exposed during disassembly. Certain packings, as noted during disassembly and assembly procedures, must be replaced on reassembly.

5-7.5. Fasteners. Replace nuts, nutplates, machine screws, bolts and other threaded fasteners if threads and wrench flats are not repairable. Replace missing or damaged rivets.

5-7.6. Flared Tubes and Flared Tube Fittings. Flared tube assemblies, tubes and fittings should be replaced only if repair is impossible. Be sure to inspect flared surfaces for cracks and deformation; check compression nuts and sleeves. Scratched flared-tube surfaces and stainless-steel fitting surfaces may often be repaired by sanding lightly with a fine abrasive material.

5-7.7. Labels, Decals and Nameplates. Labels, decals and nameplates which have become illegible or partially defaced must be replaced. Check nameplate attachments, replace loose or deformed rivets.

5-7.8. Globe Valves. The service line shut-off valve (V-3), service line vent valve (V-4), fill/drain line vent valve (V-5), fill/drain line shut-off valve (V-6), pressure buildup control valve (V-7), vapor vent line shut-off valve (V-8), fill trycock valve (V-9) and liquid level gage isolation valve (V-10) should be inspected for worn parts, deformed packings, scratched or nicked valve seats or discs.

a. Repair of these valves should be limited to the replacement of worn or damaged parts. Internal leakage through a valve is usually the result of a faulty sealing disc or damaged seat ring. External leakage, at the top of a valve bonnet, is usually the result of a damaged or worn packing or loose packing nut.

b. If the valve leaks externally, through the valve stem packing, first try to tighten the packing nut. If this fails to stop the leak, replace the packing. Check the valve stem areas in contact with the packing rings. If it is pitted or worn, replace it.

c. Kits are available (See Illustrated Parts Breakdown, T.O. 37C-8-36-4) to replace the disc and seat assemblies for globe valves.

5-7.9. Instrumentation Valves. The vacuum line shut-off valve (V-1) and the vacuum gage (thermocouple isolation) valve (V-2) are more practically replaced than repaired. Dispose of the damaged valves through the usual channels. Do not operate, remove or attempt to repair the vacuum indicator (thermocouple isolation) valve (V-2) during routine inspections. It should be opened only during vacuum efficiency tests. If it is determined that the valve is defective, it should be replaced with a new one only after breaking the vacuum (replacing the vacuum with nitrogen gas, see paragraph 5-10).

5-7.10. Inner Shell Relief Valve. The inner shell relief valve (RV-3) is a sealed (ASME Code) unit. Attempt no repairs or adjustments. If leaks are suspected (evidence is usually in the form of constant venting, frosted tubing, or the inability to achieve pressure buildup for product transfer), replace the valve, and dispose of it through normal channels. A method for testing the valve is outlined in Section VII.

5-7.11. Fill/Drain Service Line Relief Valves. Testing procedures for the determination of relief pressure appear in Section VII. Dispose of damaged valves through the usual channels.

5-7.12. Rupture Disc Assembly. Failure of the inner shell rupture disc (SD-1) is usually indicated by a failure to achieve pressure buildup for product transfer, frosted vent lines and tubing, and constant venting not associated with the inner shell relief valve (RV-3) or the vapor vent line valve (V-8). Remove and replace the rupture disc assembly by uncoupling the rupture disc tube coupling nut from the assembly and removing the rupture disc from the coupling. Do not attempt further disassembly. It must be replaced with a new unit.

5-7.13. Fill/Drain and Service Line Filters. Filters should be cleaned or replaced whenever they appear to impede the flow of product. Procedures for the removal, cleaning or replacement of the line filters appear in Section V of T.O. 37C2-8-36-1, Operation and Maintenance Instructions. Make sure that the flow arrow on the filter is pointed in the direction of liquid flow on reassembly. The fill/drain line filter arrow must point inboard, the service line filter arrow must point outboard from the tank.

5-7.14. Gages. Defective gages (liquid level LL-1 and pressure PI-1) are easily removed from the

control panel by disassembling the retaining nuts, washers, and machine screws and uncoupling the tubing couplings which attach them to the gaging system. Repairs are made with a drained and purged storage tank.

a. Gage bezels may be removed from either gage (held on with screws) without isolating the gage from the system.

b. Calibration information for the storage tank gages and the management provisions for their maintenance is found in T.O. 37C11-1-1 and T.O. 33K-1-1-00. The local Precision Management Equipment (PME) laboratories are responsible for the maintenance of gage calibration, in accordance with the applicable 33K series of technical orders. Consult with the cognizant PME laboratory on forwarding any gage for calibration, and follow the directions for handling and packing.

5-8. WELDING.

Welding/cutting operations produce heat, metal fumes, injurious radiation, metal slag and airborne particles. Approved welder's safety equipment will be used. Ventilation requirements will be determined by the Base Bioenvironmental Engineer.

All welding on the storage tank shall be accomplished by certified welders in accordance with MIL-STD-1595, using standard welding practices and procedures (Refer to T.O. 00-25-252).

5-8.1. Storage Tank Outer Jacket. Although welding on the tank jacket is not normally recommended or accomplished on the base level, the method and information are included here to prevent work stoppage or mission delay. Do not attempt to weld on the tank jacket, piping or frame until the vessel has been drained, purged, and the annular space vacuum replaced by a nitrogen atmosphere (See paragraph 5-10).

All welding on the storage tank shall be accomplished by certified welders in accordance with MIL-STD-1595 using heliarc welding only (Refer to T.O. 00-25-252).

5-8.2. Tank Frame, Saddle and Skid Frame. Welding on frame members may be accomplished by an electrical method at any level of maintenance where qualified personnel and equipment are available.

5-9. BREAKING THE ANNULUS VACUUM (See Figure 5-1).

When repairs to the outer jacket or to piping must be performed which will affect the status of the annular space, the vacuum must be replaced with a nitrogen atmosphere. No positive pressure may be applied, and the gas must be drawn into the space according to the following procedures:

a. Remove the vacuum flange from the vacuum flange adapter on the top rear of the storage tank (Figure 5-1).

b. Connect a source of low-pressure nitrogen gas (Specification BB-N-411, Grade B, Type 1) to the vacuum flange adapter. Regulate nitrogen source to 2 to 3 psig.

c. Open the nitrogen source service valve, and slowly open the vacuum valve (V-1) and allow the nitrogen to be drawn into the annular space.

d. When the nitrogen flow stops, close the source supply valve, then close vacuum valve (V-1).

e. Disconnect the nitrogen source from the vacuum flange adapter.

f. Reinstall the vacuum flange on the vacuum flange adapter. Replace the o-ring if required.

5-10. STORAGE TANK ANNULUS EVACUATION (PUMPDOWN) (See Figure 5-1).

Some deterioration of annulus vacuum over a period of time is normal. Consult periodic inspection records for an indication of this condition. As a warm storage tank will have a slightly higher pressure indication than a cold one, this condition does not necessarily indicate a vacuum loss. However, a sudden or rapid loss of vacuum may indicate leakage. A thorough and complete inspection will probably determine the cause. Do not attempt to evacuate the storage tank annular space until the cause of the vacuum loss has been determined, and, if necessary, repaired.

a. Determine the storage tank annulus vacuum level following the procedure referenced in Section VII, Testing. After the test, close the vacuum thermocouple valve (V-2).

b. Remove the vacuum flange from the vacuum flange adapter on top of the storage tank, as shown in Figure 5-1.

c. Attach a vacuum line from the vacuum pump to the vacuum flange adapter and secure it with the washers and nuts. Replace o-ring if required.

NOTE

The permanently installed thermocouple at the front of the storage tank is used to monitor the vacuum in the annular space.

d. Start the vacuum pump and read the vacuum level at the pump. It must be below 4 microns before the pump valve is opened. Record the vacuum level.

e. Do not shut-off the vacuum pump during evacuation. If power fails, or if the pump is accidentally turned off, close the vacuum valve immediately. Vacuum pump lubricant can be drawn through the hose and into the annular space, making further evacuation impossible and destroying the effectiveness of the insulation.

f. Always inspect the hose and valve after evacuation to be sure that no lubricant is in evidence. Do not confuse the appearance of the solid colorless oxygen-compatible grease used on vacuum system O-rings, which is safe; and, the light-brown, oily-appearing pump lubricant, which is unsafe. Vacuum loss due to oil ingestion will be immediate, and the storage tank must be condemned as unserviceable.

g. Slowly open the pump valve to the vacuum hose, and allow the pump to evacuate the hose for approximately ten (10) minutes. Record the vacuum level in the hose (determined by a vacuum gage installed in the hose). It should not be more than three (3) microns greater than the level recorded at the pump.

h. Open the vacuum valve (V-1) slowly. There should be a rise in the hose vacuum level, this is normal.

i. After four (4) hours of pumping, there should be a large drop in the hose vacuum, indicating that there are no leaks in the system.

j. Observe and record the vacuum level indicated by a portable gage attached to the vacuum gage thermocouple (VI-1) at the front of the storage tank. The vacuum gage (thermocouple isolation) valve (V-2) must be opened to obtain this reading.

k. Continue to pump until the desired level is indicated on the portable gage (15 microns, warm; 1 micron, cold).

l. When the annulus is evacuated to the desired level, close the vacuum valve (V-1). Turn off the vacuum pump, open the vacuum line bleed valve and allow the vacuum hose to stabilize; the hose may then be disconnected from the operator port.

m. Using the portable gage attached to the thermocouple at the front of the tank; open the vacuum gage valve (V-2), and determine and record the vacuum level of the annular space. Then monitor the indication for two (2) hours. Watch for any pressure rise that might indicate a leak.

n. Remove the vacuum line from the vacuum flange adapter. Inspect the hose and the interior of the vacuum flange adapter for evidence of pump lubricant which may have been drawn into the area by the vacuum (See Step f). If there is no contamination, replace the vacuum flange on the vacuum flange adapter with the washers and nuts. Replace the o-ring if required. If there is contamination, clean the area with freon (See Table 2-2) and test for vacuum loss (Refer to Section VII). Vacuum loss will be immediate if oil has been ingested, and the storage tank will be unserviceable.

o. When satisfied that the vacuum level has stabilized, and is within the appropriate limits, close the vacuum gage (thermocouple isolation) valve (V-2). Set the portable vacuum gage switch to OFF, and detach the gage lead from the thermocouple (VI-1).

p. To avoid vacuum loss, make sure that the vacuum gage valve (V-2) is tightly closed except when actually measuring the annulus vacuum level.

5-11. PAINTING AND MARKING.

Repair any damage to painted surfaces in accordance with MIL-STD-808 (USAF), Finishes, Protective, and Codes, for Finishing Schemes for Ground and Ground Support Equipment; and

SA/ALC Drawing 7545352, Requirements for Finishes, Protective and Codes for San Antonio ALC Ground and Ground Support Equipment. These are for Type 1 finishes, giving protection for climatic elements. Application shall be made in accordance with the above-mentioned documents, and as follows:

a. Insure that all open ports on the tank are covered with plugs or polyethylene bags.

b. The basic painting materials are:

(1) Organic zinc primer per MIL-P-85582 in accordance with drawing 7545352.

(2) For storage tanks in liquid oxygen service, the paint finish shall be polyurethane, in accordance with MIL-C-85285, and the color shall be gloss white, No. 17875, as specified in FED-STD-595A.

c. Unpainted Areas: Do not attempt to paint copper tubing and stainless steel manifolds.

d. Marking: External markings shall be in accordance with MIL-STD-130.

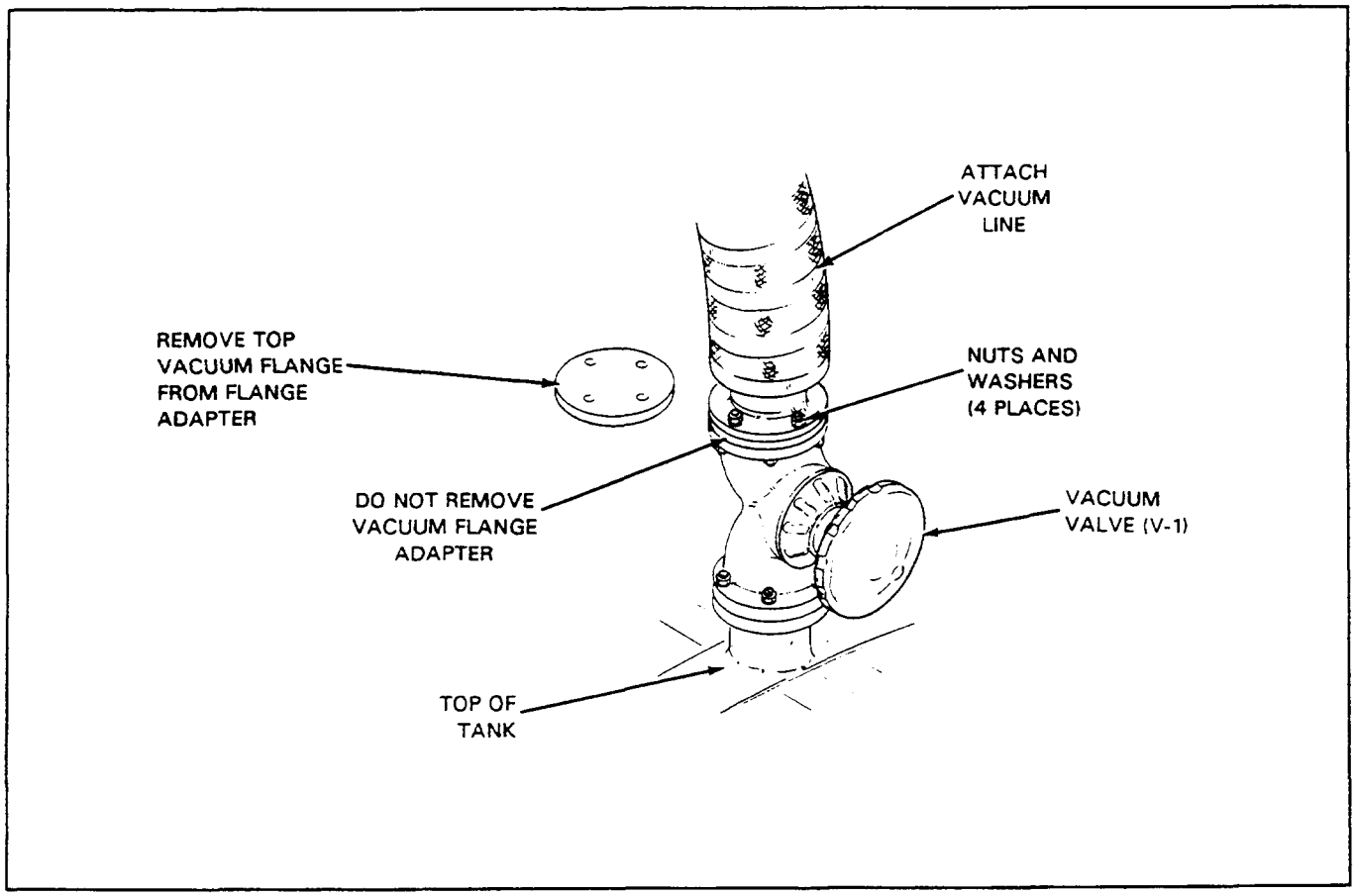


Figure 5-1. Evacuation of Annular Space using Vacuum Valve Assembly

SECTION VI
ASSEMBLY

6-1. SCOPE.

This section contains assembly instructions for the storage tank. Testing instructions are outlined in Section VII, Testing, and will be referenced, as applicable, throughout the text.

6-2. PRECAUTIONS.

6-2.1. **Cleanliness.** Cleanliness is essential for all components in contact with the product.

6-2.1.1. **Environmental Concerns.** The storage tank should be assembled in an approved clean area. Parts, tools and the general environment shall be maintained with a high degree of cleanliness at all times. Any component which ordinarily comes in contact with the product shall be assembled only in a controlled environment, using extreme care to prevent contamination of the components.

6-2.1.2. **Protection of Components.** All plugged and bagged components shall remain so until ready for assembly. Assembled components shall be plugged or bagged until ready for installation on the tank. Components contaminated during calibration of component testing shall be recleaned before final installation. All overhaul personnel shall wear clean, white, lint-free gloves while assembling components which will come in contact with the product.

6-2.2. **Prevention of Damage.** Exercise care at all times during tank assembly to avoid damage or distortion of components. Only tools most suited for a particular application may be used. A suitable fixture, vise, or other type support shall be used to support all applicable components during assembly.

6-3. GENERAL INSTRUCTIONS.

6-3.1. **Identification Tags.** All temporary identification tags shall be removed during installation of the components.

6-3.2. **Assembly of Threaded Joints and Fittings.** Thread sealant (anti-seize) tape conforming to Specification MIL-T-27730 (Refer to Table 2-2) shall be applied to the male threads of all pipe threaded fittings before assembly, except those pertaining to the vacuum system, which shall be noted. The tape shall be applied, starting with the third thread from the end of the fitting to prevent releasing tape particles into the system. Tape is to be wrapped in the direction of the threads.

6-3.3. **Lubrication.** No lubrication is to be applied to components during installation, except a small amount of stopcock grease, KEL-F-90 (Refer to Table 2-2), may be applied to the threads of the stainless steel flange bolts to prevent thread galling.

6-4. ASSEMBLY PROCEDURES.

6-4.1. **Order of Assembly.** The order of assembly of components of the storage tank is generally in the reverse order of disassembly described in Section III. References are made to the illustrations in that Section. Torque values for threaded components are presented in Section VIII, Table of Limits. The assumption is made throughout this Section that assemblies have been completely disassembled; although, this may not be the case, and most will have been disassembled only to the extent necessary to effect repairs.

6-4.1.1. **Vacuum Line Shut-off Valve Assembly. (See Figure 3-11).** Installation of vacuum line shut-off valve components should not be attempted unless the annular spare has been purged and filled with dry nitrogen gas (Refer to Section V).

a. Lightly coat o-rings (5,8,12) with vacuum grease (MIL-G-27617, Table 2-2).

b. Install flange (3) and o-ring (5) on adapter (4) and secure with nuts (1) and washers (2).

c. Install o-ring (8) and install adapter (4) on valve (11). Secure with washers (7) and nuts (6).

d. Install o-ring (12) and position valve (11) on studs on tank and secure with washers (10) and nuts (9).

6-4.1.2. **Thermocouple and Vacuum Gage Valve Assembly (See Figure 3-10).** Installation of the thermocouple and vacuum gage valve should not be attempted unless the annular space has been purged and filled with dry nitrogen gas (Refer to Section V). These instructions are only offered as a method of replacement of parts following valve or thermocouple failure.

a. Apply vacuum sealing compound (Refer to Table 2-2) to the male threads, beginning one thread away from the end of the welded pipe nipple, and install vacuum gage valve (2) on the tank vacuum gage fitting. Tighten until firm, but do not over torque. The compound will provide sufficient sealing.

CAUTION

Do not use any tool to operate the vacuum gage valve. Over-tightening the valve knob will cause permanent damage.

b. Apply vacuum sealing compound to the male threads of the thermocouple tube (1), beginning one thread away from the end. Install the thermocouple on gage valve (2), (do not over-torque).

c. Test per paragraph 7-5.2.1.

d. Make sure that the thermocouple valve (2) is closed.

6-4.1.3. **Cabinet Assembly.** (See Figure 3-9).

a. Install 2 brackets (42) and secure with screws (44) and nuts (43).

b. Install latch (45) and secure with screws (47) and nuts (46).

c. Install handle (39) and secure with screws (41) and nuts (40).

d. Install 2 door bars (36) and secure with screws (38) and cotter pins (37).

e. Install 2 pawls (35) and pawl brackets (31,32) and secure with screws (34) and nuts (33).

f. Install 4 keepers (13) and secure with screws (15) and nuts (14).

g. Install hinge (72) on cabinet (75) and secure with 18 screws (74) and 18 nuts (73).

h. Install right door (50) on hinge (72) and secure with 17 screws (52) and 17 nuts (51).

i. Install hinge (22) on cabinet (75) and secure with 18 screws (24) and 18 nuts (23).

j. Install left door (19) on hinge (22) and secure with 17 screws (21) and 17 nuts (20).

k. Install cabinet top (1) and secure with 11 screws (3) and 11 nuts (2).

l. Replace placards and nameplates that were removed and attach with rivets.

6-4.1.4. **Fill Drain Line Assembly (See Figure 3-8).**

a. Install valve body (38) and pipe (37) on pipe (39).

b. Install valve body (36) on pipe (39). Then install pipe (35) and elbow (34) on valve body (36).

c. Install filter (33), pipe (32) and elbow (31) on pipe (35). Make sure filter (33) flow arrow is pointing toward pipe (35).

d. Install adapter (30) over elbow (31) and install coupling assembly (26). Wrench notch to be at top dead center. If coupling assembly (26) was disassembled, install gasket (28) and cap (29) onto seat (27).

e. Connect pipe (25) to PBU and secure with screws (24), flat washers (42), belleville washers (23), gasket (40) and nuts (22).

f. Install bracket (21) and secure to frame with bottom two screws (20), washers (19), and nuts (18).

g. Position assembly that was assembled in a through d into cabinet, install gasket (41), and secure with screws (13), washers (12), nuts (11); top two screws (20), washers (19) and nuts (18) that attach adapter (30) to bracket (21).

h. Install gasket (17) between pipe (37) and pipe (25) and connect with screws (16), washers (15) and nuts (14).

i. Install valve body (6) on cabinet base valve mount and secure with bars (9), washers (8), and nuts (7).

j. Install elbow (10) and tee (5) on valve (6).

k. Connect tube (2) between tee (5) and elbow (34).

l. Install relief valve (4) and connector (3) on tube (1) and connect tube to tee (5).

m. Install stem and bonnet assemblies on valve (V-5), (V-6) and (V-7) per paragraph 6-4.1.10.

6-4.1.5. Service Line Assembly. (See Figure 3-7)

a. Assemble pipe (26), valve body (25) and pipe (24).

b. Install gasket (30) between pipe (26) and tank and secure sub-assembly (24,25,26) to tank with screws (29), washers (28) and nuts (27).

c. Install bracket (7) and secure to frame with the two lower screws (6), washers (5) and nuts (4).

d. Install adapter (23), filter (22) and pipe (21). Make sure filter (22) arrow is pointing toward the coupling assembly (8).

e. Install elbow (20) on pipe (21) and slide adapter (12) onto pipe (21).

f. Install coupling assembly (8). Wrench notch to be at top dead center. If coupling assembly was disassembled, install gasket (10) and cap (11) into seat (9).

g. Secure assembly to bracket (7) with top two screws (6), washers (5) and nuts (4).

h. Install valve body (14) on cabinet base valve mount and secure with bars (3), washers (2) and nuts (1).

i. Install elbow (13) and tee (19) on valve body (14).

j. Connect tube (18) between tee (19) and elbow (20).

k. Install relief valve (17) and connector (16) on tube (15) and connect tube to tee (19).

l. Install stem and bonnet assemblies on valves (V-3) and (V-4) per paragraph 6-4.1.10.

6-4.1.6. Vent Line Assembly. (See Figure 3-6).

a. Install and connect pipe (12) to PBU and install left side of PBU per paragraph 6-4.1.8.

b. Install gasket (11) between pipe (12) and pipe assembly (13) and install screws (10), washers (9) and nuts (8).

c. Install gasket (24) between pipe assembly (13) and pipe assembly (3) and install screws (23), washers (22) and nuts (21).

d. Install pipe (7), rupture disc (6), pipe (5) and elbow (4) on pipe assembly (3).

e. Install relief valve (2) and pipe (1) on pipe assembly (3).

f. Install valve body (16) on pipe assembly (3) and pipe (15) and coupling (14) on valve body (16).

g. Install both halves of spacer (25) around pipe (15) and secure with screws (26) and nuts (27).

h. Install bonnet and stem assembly in valve (16) per paragraph 6-4.1.9. except the 2 nuts (17) that secure bracket (18).

i. Install nametag (19) on bracket (18) and secure with rivets (20).

j. Install bracket (18) on valve body (16) and secure with nuts (17).

6-4.1.7 Instrument Panel Assembly. (See Figure 3-5).

a. Install nameplates (28,29,30) and secure with rivets (31).

b. Install liquid level gage (16) in panel (32) and secure with screws (27) and nuts (26).

c. Install cover (25) on liquid level gage (16) and secure with screws (24).

d. Install pressure gage (13) in panel (32) and secure with screws (23) and nuts (22). Install cover (21) on pressure gage (13).

e. Install locknut (20), union (19) and cap (18) in panel (32).

f. Install elbow (12) on pressure gage (13) and elbows (14,15) on liquid level gage (16).

g. Connect tube (9) between elbow (14) and valve (10).

h. Connect tube (8) between union (19) and tee (11).

i. Connect tube (7) between elbow (15) and tee (11).

j. Connect tube (6) between tees (11).

k. Connect tube (5) between elbow (12) and tee (11).

l. Carefully position panel (32) into cabinet and secure with screws (4), washers (3) and nuts (2).

m. Connect both ends of two tubes (1).

6-4.1.8. PBU Assembly. (See Figure 3-4).

a. Install gasket (29) between inlet tube (30) and fill/drain assembly and secure together with screws (28), flat washers (27), flat washers (26), belleville washers (25) and nuts (24).

b. Install gasket (31) and baffle (7) into inlet tube (30). Note notch position on gasket (31).

c. Using wrench to hold vent piping, screw outlet tube (23) onto vent piping.

d. Place insulator (22) between 4 studs on frame.

e. Install gasket (13) and gasket (6) between inlet and outlet tubes and crossover tube (21). Note notch position on gaskets (6,13).

f. Secure crossover tube (21) to outlet tube (23) with screws (12), belleville washer (9), flat washers (10,11) and nuts (8).

g. Secure crossover tube (21) to inlet tube (30) with screws (5), belleville washers (2), flat washers (3,4) and nuts (1).

h. Install rear bracket (20) over crossover tube (21) and secure to studs with belleville washers (18), flat washers (19) and nuts (17).

i. Install clamps (16) over inlet and outlet tubes (23,30) and secure to frame with washers (15) and nuts (14).

6-4.1.9. Globe Valve Assembly (V-8). (See Figure 3-3).

a. Using the appropriate special wrench (refer to Table 2-1), install seat (15) in valve body (16).

b. Install disc insert (12) and disc plate (11) onto disc holder (13), and secure with disc nut (10).

c. Insert stem (14) into valve bonnet (6) and turn it counter-clockwise to engage the stem threads with those on the bonnet.

d. Place packing (5) on valve stem (14) and push it down into the bonnet. Then place packing gland (4) on the stem and push it down to cover the packing.

e. Install packing nut (3) on stem.

f. Do not over-torque the packing nut. Turn it clockwise until it is firm. The packing nut area must be leak-checked, and the nut tightened to prevent leaks when pressure is applied to the system during testing (See Section VII).

g. Install gasket (9) in valve body (16) and install plug assembly (17) on stem. Place the stem/bonnet assembly on valve body (16). Secure stem and bonnet assembly to valve body with nuts (7).

h. Install handwheel (2) on top of stem (14) and secure it with nut (1).

6-4.1.10. Globe Valve Assembly (V-3, V-4, V-5, V-6, V-7, V-9) (See Figure 3-2).

a. Using the appropriate special wrench

(refer to Table 2-1), install seat (15) in valve body (16).

b. Install disc locknut (13) on valve stem (14) and lock it in place with horseshoe ring (12).

c. Holding locknut (13) with a suitable wrench, screw on disc holder (11).

d. Install disc insert (10) and disc plate (9) and secure with disc nut (8).

e. Insert stem (14) into valve bonnet (7) and turn it counter-clockwise to engage the stem threads with those on the bonnet. Install bonnet nut (6) on bonnet (7).

f. Place packing (5) on valve stem (14) and push it down into the bonnet. Then place packing gland (4) on the stem and push it down to cover the packing.

g. Install packing nut (3) on stem.

h. Do not over-torque the packing nut. Turn it clockwise until it is firm. The packing nut area must be leak-checked, and the nut tightened to prevent leaks when pressure is applied to the system during testing (See Section VII).

i. Place the stem/bonnet assembly on valve body (16). Engage the bonnet nut with the threads at the top of the body and tighten with a suitable wrench.

j. Do not over-torque the bonnet nut. This is a metal-to-metal connection, and can be damaged by excessive tightening. This area must be leak-checked when pressure is applied to the system; and then, tightened to stop any leaks.

k. Install handwheel (2) on top of stem (14) and secure it with nut (1).

6-4.1.11. Service Hose Assembly (See Figure 3-1).

a. If the service hose coupling assembly (3) has been completely disassembled, reassemble the coupling nut (5) with the coupling cone (6) and plug (4), and secure them together by placing the coupling retaining ring (7) in the cone ring groove.

b. Place the 2 couplings (3) on nipples (2) and turn them clockwise until threaded to a depth of approximately 11/16-inch. Install "S"-hook (8) and chain (9).

c. Put coupling and nipple on hose.

d. Remove dust cap from service hose coupling and plug from hose coupling. Holding the hose, connect the coupling (3) to service line coupling.

e. Install hose into support in the cabinet.

SECTION VII
TESTING

7-1. SCOPE.

This section contains procedures for testing individual components, and tests to be performed after repairs and reassembly of the storage tank.

7-2. PRECAUTIONS.

All of the following precautions must be observed by personnel conducting the tests outlined in this section. All persons operating this storage tank must be thoroughly familiar with the hazards involved in handling of liquid oxygen.

7-3. EQUIPMENT OPERATIONAL SAFETY.

The storage tank presents several hazards which must be addressed by the operator. The equipment and products are not dangerous in themselves. Failure to observe normal precautions can lead to serious injury to personnel and severe equipment damage.

7-3.1. Static Grounding. A static grounding lug is installed at the rear of the storage tank for the attachment of a grounding cable. It must be attached to proper ground during testing and operation.

7-3.2. Relief and Vent Valves. Personnel must be constantly aware that vapor or liquid product may be vented from the system at any time. The vapor vent line directs discharged gas down and away from the control housing. It must be clear of all obstructions, including plugs, tape and external blockages.

7-3.3. Control Valves. The manual control valves are installed on the control panel, exposed by opening the front door of the control housing. They should be operated in the manner indicated in T.O. 37C2-8-36-1, Operation and Maintenance Instructions.

7-3.4. Confinement of Product. Never confine the liquid product in any piping or closed container. This creates an extremely dangerous "pipe bomb" condition as the product expands to gas, creating a tremendous pressure in the confined space.

7-4. MEASUREMENTS AND INSTRUMENTATION.

7-4.1. Accuracy of Measurements. All apparatus used in testing shall be of laboratory precision type as far as practicable, and shall be calibrated at intervals properly spaced to continue laboratory accuracy.

7-4.1.1. Gage Pressures. Data on gage pressures measured in the range from 0 to 100 psi shall be accurate to within two (2) percent of full scale.

7-4.1.2. Weight Measurements. Data on product measurements obtained by scale weights of the storage tank and the product shall be accurate to within five (5) percent.

7-4.1.3. Gas Flow Rates. Data on gas flow rates shall be accurate to within three (3) percent.

7-4.2. Instrumentation.

7-4.2.1. Tank Pressures. Tank pressures above the atmospheric pressure shall be measured by the tank pressure gage (PI-1) on the control panel. Coupling C-3 is provided to verify the accuracy of pressure gage PI-1.

7-4.2.2. Liquid Level. The storage tank liquid content shall be measured by the liquid level gage (LL-1) on the control panel, or by weighing the entire unit. Weighing should be measured by scales designed for this particular type of measurement and shall be recorded in pounds (which may then be converted to gallons). The liquid level gage will not present an accurate indication during filling, draining or pressure buildup operations due to pressure surges. Allow the product to stabilize before recording indications from the liquid level gage.

7-5. TESTING PROCEDURES.

7-5.1. Cleanliness Testing. Refer to Section V, Paragraph 5-6 for inspection of both the interior and exterior of the storage tank.

7-5.2. Leak Detection. Leakage, internal and external, is often indicated by observation. Thus, frosted piping presents evidence that product is escaping through a valve; cold spots on the tank jacket are indicative of a possible vacuum leak; and, a frosted valve stem can be caused by a worn packing or a packing nut that needs to be tightened. These symptoms and suggested remedies are displayed in the Trouble Shooting Table (Section V, in T.O. 37C2-8-36-1). However, very small leaks, such as a loss of 10 to 50 microns of vacuum per day, cannot be detected or repaired by ordinary methods.

7-5.2.1. Vacuum Leak Detection. Vacuum leak detection requires contractor or depot facilities, trained and experienced personnel, and the employment of helium mass spectrometer equipment. The method is outlined below for general information:

a. The inner vessel must be drained of all liquid product and be at ambient temperatures before any testing.

b. Leakage of the inner vessel into the annular space will generally be indicated by the annular valve (SD-2) plate being forced from the valve. This type of leak cannot be field-repaired.

c. Attach a vacuum line to the vacuum valve (V-1, Figure 5-1) and attach a mass spectrometer leak detector (See Table 2-1) to its vacuum outlet. Using a vacuum pump, evacuate the line from the spectrometer to the valve.

d. Open the vacuum valve to connect the annular space vacuum to the mass spectrometer.

e. Use a helium jet spray to check all welded seams between the inner and outer vessel and jacketed piping. Keep the spectrometer remote control sensor close at hand for quick leak detection.

f. Report leaking weldments to the proper authority. Do not perform make-shift repairs. See Paragraph 5-8.

g. When leak testing is complete, close the vacuum valve, and remove the spectrometer tube from the outlet. Remove vacuum line from valve and replace cover.

NOTE

The technique for determining the level of vacuum in the annular space is outlined in Section V of T.O. 37C2-8-36-1, using vacuum gage assembly NSN 6685-00-115-9602YD (Refer to Table 2-1).

7-5.2.2. Pressure Leak Detection. Pressure leak detection consists primarily of pressurizing the piping system, and making a "bubble test" with Leak Detection Compound (MIL-C-25567, refer to Table 2-2).

a. Attach the storage tank to a regulated source of clean, dry nitrogen gas (Specification BB-N-411, see Table 2-2) through the fill/drain coupling (or, having removed the coupling and making direct attachment through the fill/drain nipple assembly. Open the fill/drain shut-off valve (V-6) and regulate the gaseous nitrogen pressure to 50 psi (as noted on both the nitrogen source gas gage and the tank pressure gage).

b. Following the instructions packaged with the leak detector compound, apply the compound to each flange joint, threaded joint, the bonnet and packing nuts, and paying particular attention to fittings to the gage.

c. Tighten plumbing joints to stop leaks. If tightening fails to stop the leaks, disassemble and determine the cause of the problem. Check valve seats and plug assemblies, replacing parts as necessary. Make sure that all threaded joints are sealed with anti-seize tape (MIL-T-27730, Table 2-2).

d. After all repairs have been made, pressurize the tank to 50 psi and allow it to stabilize for 24 hours at constant temperature. Check gages for pressure loss. If pressure loss is excessive, recheck for leaks. Temperature changes can cause slight variations in tank pressure and must be considered.

7-5.3. Evaporation Loss Testing. This test will determine the adequacy of the insulation and vacuum in the storage tank annular space. This is accomplished by measuring the evaporation loss rate at ambient temperature and pressure.

7-5.3.1. Volume Method. This procedure requires

the use of a totalizing flowmeter (Refer to Table 2-1), usually available from the PMEL or Fuels Laboratory.

a. Fill the storage tank to 50% capacity (2500 gallons) and allow the liquid to stabilize for a minimum of 48 hours, passing all vapor through a totalizing flowmeter.

b. Record the volume of vapors which have flowed through the meter for the next 24 hours and calculate the weight of the evaporated product. It must not exceed 120 pounds for a 24-hour period.

c. Disconnect the flowmeter and return valve to its normal condition.

7-5.4. Vacuum Retention Testing. This test is related to both the leak testing and evaporation loss testing procedures, and is a supplementary verification of their results.

a. Fill the storage tank with not less than 1200 gallons of liquid product, and allow it to stabilize for a minimum of 24 hours.

b. Following the techniques outlined in Section V of T.O. 37C2-8-36-1, Operation and Maintenance Instructions, using a vacuum gage (Refer to Table 2-1), determine the vacuum level of the annular space.

c. Permit the storage tank to remain undisturbed for a minimum of one hundred and sixty-eight (168) hours (7 days), and then repeat the test of paragraph b. The annular space absolute pressure shall not exceed 35 microns H_g or show any increase in pressure attributable to outgassing or leaks.

7-5.5. Relief Valve Testing. The line relief valves (RV-1 & RV-2) may be tested by attaching them to a regulated source of dry nitrogen gas, and increasing the pressure until they open to relieve. The tank pressure relieve valve (RV-3) may be tested by increasing the pressure in the storage tank (using the pressure buildup valve) and noting the pressure at which the valve relieves; or by removing the valve from the vapor vent manifold and testing it in the same manner as the line relief valves.

CAUTION

Do not attempt to adjust any of the relief valves. The tank pressure relief valve is a sealed, ASME-Code-certified unit. Do not tamper with it.

7-5.5.1. Line Relief Valves. Line relief valves (RV-1, RV-2) should relieve at 75 ±5 psig, and reseat at between 60 psig and 2 psig less than the opening pressure.

7-5.5.2. Inner Shell Relief Valve. The inner shell relief valve (RV-3) should relieve at 60 ±5 psig, and reseat between 48 psig and 2 psig less than the opening pressure.

SECTION VIII
TABLE OF LIMITS

8-1. SCOPE.

This section consists of a Table of Limits (Refer to Table 8-1), applicable to the equipment covered by this manual. Maximum and minimum limits refer to clearances, torques, pressures, etc., beyond which the item may not be continued in service.

Table 8-1. Table of Limits

Item Description	Limits
#10 Machine Screws/Nuts	Torque 21 to 27 in/lbs.
1/4-Inch Machine Screws/Nuts	Torque 50-66 in/lbs
3/8-Inch Machine Screws/Nuts	Torque 15 to 20 ft/lbs.
Tank (Safety) Relief Valve	Set at 60 ±5 psig.
Line Relief Valve (2)	Set at 75 ±5 psig.
Rupture Disc	Rated at 91 $^{+9}_{-5}$ psig.

SECTION IX
ILLUSTRATED PARTS BREAKDOWN

9-1. ILLUSTRATED PARTS BREAKDOWN.

The Illustrated Parts Breakdown for the storage tank is contained in T.O. 37C2-8-36-4.

SECTION X
DIFFERENCE DATA SHEETS

Not Applicable

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